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REVISION OF THE CHINESE MECOPTERA

BY FUNG YING CHENG

Harvard University and
National Taiwan University

WITH TWENTY-THREE PLATES

CAMBRIDGE, MASS., U. S. A.
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No. 1 — *Revision of the Chinese Mecoptera*

By Fung Ying Cheng

INTRODUCTION

The Mecoptera, commonly called scorpion flies and hanging flies, are widely distributed over the Northern Hemisphere and are well represented in China. However, little collecting of these insects has actually been done in China, especially in the interior regions. It was my good fortune to be a member of the entomological expedition of the Sino-British Committee, extending from June 1939 to July 1940; this was mainly restricted to Szechwan, Sikang and Shensi Provinces. The present study is based largely on specimens collected on this expedition. Since I have been able to examine type specimens in the Museum of Comparative Zoology, the U. S. National Museum and the Heude Museum, and also material in the Museum of the Institute of Zoology, Academia Sinica, Museum of Foochow University, Chou Collection, Issiki Collection and Maa Collection, I have included an account of all species described from China.

I wish to express my sincere thanks to all the curators of these museums and the owners of private collections for the loan and gift of material and for their kind coöperation which has made this study possible: Dr. P. J. Darlington, Dr. J. C. Bequaert, Museum of Comparative Zoology; Dr. A. B. Gurney, U. S. National Museum; Dr. Sieien H. Chen, Academia Sinica; Father de Cooman, Heude Museum; Dr. Hsiu Fu Chao, National Foochow University; Dr. Chou, Chang-chia-kang; Dr. S. Issiki, Tokyo and Mr. Maa, Taipeh.

Furthermore, I am deeply indebted to Professor F. M. Carpenter of Harvard University for his encouragement during the course of my study and for his kindness in reading over this paper.

HISTORICAL ACCOUNT

The order Mecoptera comprises about three hundred and thirty described species from the entire world. Until recently, only a few of them were known from China. In 1921, Esben-

Petersen recorded only eight species from there in his monographic revision of the order. In 1937, Wu reported nineteen species in his "Catalogus Insectorum Sinensium," fifteen species belonging to Panorpidae and four species to Bittacidae. In 1938, Carpenter listed twenty-eight species of Panorpidae. In the past ten years, more new species have been described by Carpenter, Tjeder and myself. The number of described species has thus been brought to fifty-seven. In the various collections which I have examined recently, twenty-five additional species have been found, bringing the total number of known Chinese species to eighty-two.

Because of its geographical nature, the mainland of China has been separated into thirty provinces. Scorpion flies and hanging flies occur in all those (about half) to which expeditions have been made. Since previous expeditions did not include most of the mountainous areas of any of the provinces and no expeditions at all have been made for Mecoptera in fifteen of the provinces, I believe our collections and knowledge of this order in China are still very incomplete.

SYSTEMATIC ACCOUNT

Of the five existing families of Mecoptera, only two have been found in China. They can be recognized as follows:

Tarsi with two claws, not raptorial.....Panorpidae
Tarsi with a single claw, modified for raptorial....Bittacidae

Family PANORPIDAE

Panorpidae Stephens, 1836, Ill. Brit. Ent., Enderlein, 1910, Zool. Anz., **25**: 385. Esben-Petersen, 1921, Coll. Zool. Selys Long., **5**(2): 11. Carpenter, 1931, Bull. Mus. Comp. Zool., **72**(6): 209.

Ocelli present; labial palpi two-segmented; abdomen cylindrical or nearly so, tapering to a point in the female, without ovipositor; 6th to 8th abdominal segments of male narrowly cylindrical, apical segment modified, usually enlarged; tarsi with two claws, not modified for grasping; wings more or less slender, with primitive venation; costal space narrow, with few crossveins; R_s originating at about one-third of wing length from base; M dividing near the middle of wing.

Three of the six existing genera of the family inhabit China, namely, *Panorpa*, *Neopanorpa* and *Leptopanorpa;* the fourth genus, *Panorpodes* occurs in Japan, the fifth *Apteropanorpa* in Tasmania, and the sixth, *Brachypanorpa* in North America. Both

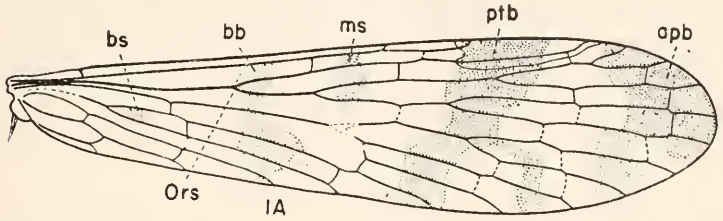

Fig. 1. Wing venation and markings of *Panorpa:* 1A, first anal vein; apb, apical band; bb, basal band; bs, basal spot; ms, marginal spot; Ors, origin of radial sector; ptb, pterostigmal band.

Panorpa and *Neopanorpa* were found in most of the Chinese provinces where expeditions have been made. *Leptopanorpa* is represented by a single species found in Hainan, Kwangtung. As a matter of fact, however, the latter locality is an island, separated from the mainland by the sea. The three genera occurring in

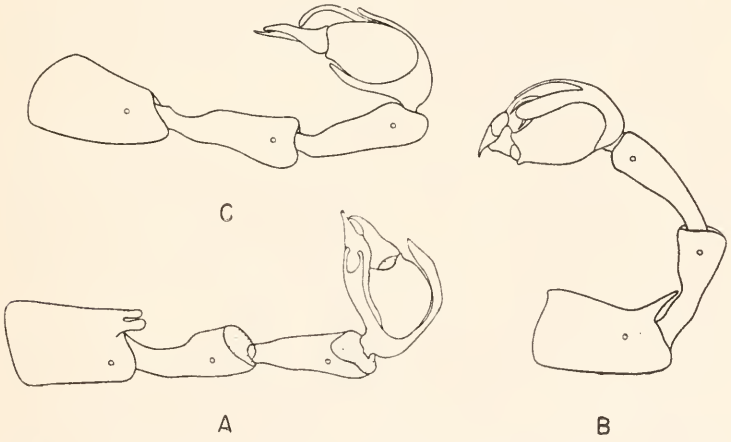

Fig. 2. The 6th to 9th abdominal segments of *Panorpa:* A, *kimminsi* Carpenter (*diceras* group); B, *obtusa* Cheng (*centralis* group); C, *cladocerca* Navas (*davidi* group).

China can be distinguished as follows:

1. 1A joins the anal margin of wing far beyond the origin of radial sector (text-fig. 1) ..... *Panorpa*
   1A joins the anal margin of wing before the origin of radial sector (text-fig. 3) 2
2. Abdomen in the male only as long as the wings or shorter; 6th to 9th abdominal segments normal or only a little prolongated (text-fig. 4) ..... *Neopanorpa*
   Abdomen in the male much longer than the wings; 6th to 9th segments much prolongated (text-fig. 5) ..... *Leptopanorpa*

Genus PANORPA Linné

Panorpa Linné, 1758, Syst. Nat., **10**:551. Klug, 1836, Abh. Königl. Akad. Wiss. Berl., 1836:88. Rambur, 1842, Hist. Nat. Ins. Nevr., 1842:328. Westwood, 1846, Trans. Ent. Soc. London, **4**:184. Loew, 1848, Linn. Ent., **3**:363. Brauer and Löw, 1857, Neuropt. Austr., 1857:35. Brauer, 1863, Verh. Zool.-bot. Ges. Wien, **13**:307. *Id.*, 1871, Verh. Zool.-bot. Ges. Wien. **21**:109. McLachlan, 1868, Trans. Ent. Soc. London, 1868:209. Klapálek, 1896, Rozp. Ceské Akad. Cisare Frantis. Josefa, 1896:1. Felt, 1896, New York State Ent. Rep., **10**:463. McClendon, 1906, Ent. News, 1906:121, fig. 14. Stitz, 1908, Zool. Jahrb., **26**:537. Mjöberg, 1909, Ent. Tidskr., 1909:160. Enderlein, 1910, Zool. Anz., **35**:389. Miyake, 1912, Journ. Coll. Agric. Imp. Univ. Tokyo, **4**:137. *Id.*, 1913, Journ. Coll. Agric. Imp. Univ. Tokyo, **4**:335. Banks, 1913, Trans. Am. Ent. Soc. 1913:232. Esben-Petersen, 1921, Coll. Zool. Selys Long., **5**(2):13. Carpenter, 1931, Bull. Mus. Comp. Zool., **72**(6):213.

Aulops Enderlein, 1910, Zool. Anz., **35**:390.

Estenella Navas, 1912, Rev. Russe d'Ent., **12**:356.

Rostrum long and slender; tarsal claws serrated on inner margins; wings are fully developed, rather broad, 1A long, extending to the anal margin of wing beyond origin of the radial sector; abdomen in both sexes not longer than the wings. 6th to 9th abdominal segments of male usual, not much prolongated; genital bulb of male not pedunculate basally.

Genotype: Panorpa communis Linné.

This is the largest genus of Mecoptera, including one hundred and sixty-two known species in the whole world. Thirty species have been already recorded in China and ten new ones are described below, making a total of forty. They are distributed throughout eleven provinces. As suggested by Carpenter (1938), these species can be conveniently divided into three groups, de-

pending upon the structure of the 6th abdominal segment of the male — that is, whether the anal horn is present, absent, or represented by two similar processes. In the first or *diceras* group, with double anal horn, belong *diceras* McLachlan, *tjederi* Carpenter, *stotzneri* Esben-Petersen and *kimminsi* Carpenter; in the second or *centralis* group, with a single anal horn, belong *centralis* Tjeder, *flavipennis* Carpenter, *emarginata* Cheng and *obtusa* Cheng; in the third or *davidi* group, without anal horn, belong *davidi* Navas, *stigmalis* Navas, *waongkehzengi* Navas, *difficilis* Carpenter, *fructa* Cheng, *cladocerca* Navas, *trifasciata*

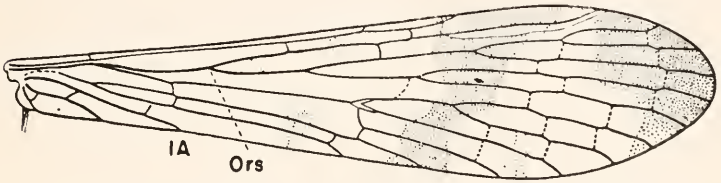

Fig. 3. Wing venation of *Neopanorpa:* 1A, first anal vein; Ors, origin of radial sector.

n. sp., *flavicorporis* n. sp., *cheni* n. sp., *obliqua* Carpenter, *baohwashana* n. sp., *typicoides* Cheng, *fukiensis* Tjeder, *curva* Carpenter, *aurea* n. sp., *coomani* n. sp., *japonica* Thunberg, *tetrazonia* Navas, *sexspinosa* Cheng, *tincta* Navas. Other species, *implicata* n. sp., *lutea* Carpenter, *klapperichi* Tjeder, *semifasciata* Cheng, *leei* Cheng, *grahamana* n. sp., *carpenteri* n. sp., *statura* Cheng, *pusilla* Cheng, *pieli* n. sp. and *bonis* Cheng, are known only from the female, so that their position in the above grouping is not determinable.

Other characteristics which have been used under each group of *Panorpa* are the wing markings and the general aspect of both male and female genitalia. The former characteristic sometimes appears to be similar from one species to another and in some cases passes through a little range of variation, while the latter remain perfectly stable even in minute details. In identification, therefore, I use the wing markings to assist in the first determination of the species and then the characteristics of both male and female genitalia for the final decision.

In the wings of *Panorpa,* the color of the membrane is a convenient feature for general classification. In some species, the wings are clear and colorless (*kimminsi,* fig. 271), in others they are distinctly yellow (*flavipennis*), and in some others, they are faintly yellow (*aurea,* fig. 281). The markings of the wings are readily grouped into several categories, depending upon how heavy the markings are. In some species, in which the wing is

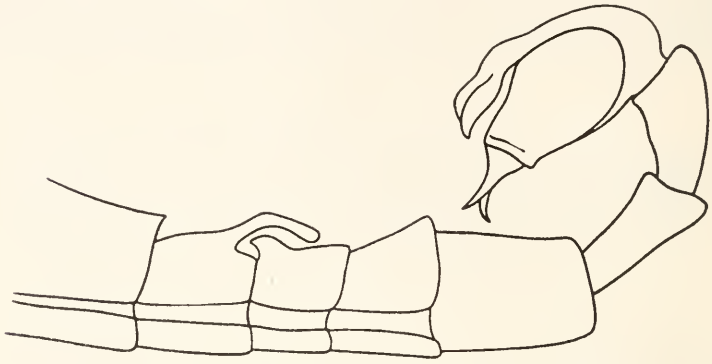

Fig. 4. Male abdominal segments of *Neopanorpa tienmushana* n. sp.

heavily marked (*japonica,* fig. 286), there are three transverse bands and two spots: these are designated the pterostigmal band, the basal band, the apical band, the basal spot and the marginal spot (text-fig. 1). In other species the wing is lightly marked, the bands are very narrow, the basal spot and the marginal spot are usually absent, and sometimes both pterostigmal and apical

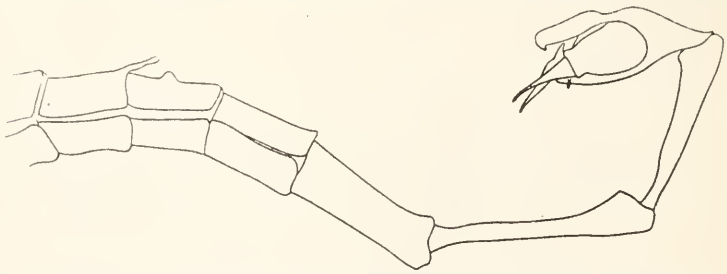

Fig. 5. Male abdominal segments of *Leptopanorpa javanica* (Westwood).

bands are interrupted or incomplete (*semifasciata,* fig. 274). In some other species, no markings are present, except for a slight suspicion of shadow at the wing apex (*obtusa,* fig. 272). Curiously enough, all species bearing the anal horn belong to the latter category, the only exception being *flavipennis,* which has a distinctly yellow wing membrane and very narrow basal, pterostigmal and apical bands. It is interesting to note that the single anal horn of this species is exceptionally short (fig. 13), quite different from the other single or double horn species. As worked out by Carpenter in his "Revision of the Nearctic Mecoptera" (1931), the venational characteristics of *Panorpa* are purely individualistic and could not be used for the classification of the species. The same statement applies to all the Chinese *Panorpa* from Fukien — the only locality from which sufficient specimens have been collected to allow a conclusion.

The male genital segment (or 9th segment), modified into a bulb, consists of an upper tergite (preëpiproct), a lower sternite (hypandrium) and a pair of two-segmented structures in between, the basal U-shaped coxopodites and the distal hooked harpagones. In some species there is a papilla at the inner distal margin of each of the coxopodites (*curva,* fig. 52, *davidi,* fig. 57), and in others a number of black spines at the same place (*sexspinosa,* fig. 87, *centralis,* fig. 10). The harpagones vary much in shape and degree of development; in most species there is a concave area on the inner basal surface of each harpagone (*centralis,* fig. 10, *davidi,* fig. 57). In others, instead of a concave area, there is an expansion or lobe at the same place. This lobe may be very small (*japonica,* fig. 90), greatly enlarged (*baohwashana* n. sp., fig. 83), or tooth-shaped (*diceras,* fig. 7), or it may arise at a different level (*trifasciata* n. sp., fig. 49, *cheni* n. sp., fig. 86). The preëpiproct is visible as a single external appendage from a dorsal aspect of the bulb. In most of the species, it has a pair of distal lobes (*diceras* etc., fig. 2), but in *waongkehzengi,* the lobes are so inconspicuous that the apex of the preëpiproct appears only slightly emarginated (fig. 43), and in *japonica,* no lobes occur at all, the preëpiproct terminating as a rounded posterior margin (fig. 85). The hypandrium appears as a basal plate from a ventral view of the bulb; this is usually produced into two long lobes, the hypovalvae. In some species

the hypandrium is long and stalk-like (*japonica,* fig. 90, *stigmalis,* fig. 33); in many others, it is inconspicuous (*emarginata* etc., fig. 31). The hypovalvae are generally slender and flattened (*flavipennis,* fig. 11), while in *baohwashana* n. sp., they are broadened towards the apex with upwardly folded outer margins (fig. 83). In the interior of the bulb, between the bases of the coxopodites arises an irregular aedeagus from the wall of the genital pouch. This usually has a pair of prominent apical processes and a pair of lateral processes. In some species, the apical processes are very short and inconspicuous (*tjederi,* fig. 6); in others, they are very long (*curva,* fig. 52), and in some others they have greatly enlarged distal ends (*difficilis,* fig. 46). At

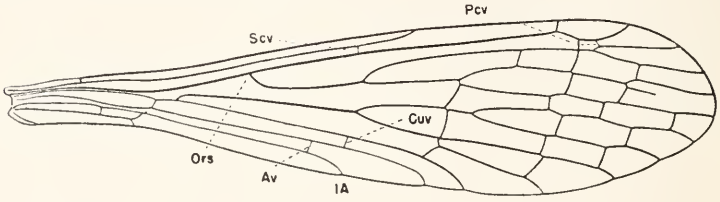

Fig. 6. Wing venation of *Bittacus:* 1A, first anal vein; Av, anal crossvein; Cuv, cubital crossvein; Ors, origin of radial sector; Pcv, pterostigmal crossvein; Scv, subcostal crossvein.

the sides of aedeagus are two slender parameres supported on a U-shaped bar in the ventral wall of the genital chamber proximal to the base of the aedeagus. The parameres exhibit a remarkable series of modifications in different species. They are strongly sclerotized and very stiff, usually blackish brown in color and with a cluster of spines, resembling the barbs in a bird's feather, on their inner margins and their distal ends. In some species the parameres are reduced to a very minute linear thread without spine (*japonica,* fig. 90), while in most others they are long with prominent barbs (*centralis* group, fig. 10, *davidi* etc., fig. 57). In some species, they are Y-shaped (*aurea* n. sp., fig. 62), in others they have 3-4 branches (*diceras* group, fig. 7). Curiously enough, even the extending direction and the approximate number of the spines of this appendage are constant in the species.

The female genital segment (or 9th segment) consists of an upper normally developed tergite and a lower subgenital plate which has a free posterior margin forming an opening for the genital cavity. In some species, the subgenital plate is very broad and its lateral margins overlap the sides of the 9th tergite (*tjederi,* fig. 12); others are narrow and their lateral margins are enclosed by the well developed 9th tergite (*semifasciata,* etc., fig. 122). The posterior margin of the subgenital plate differs from species to species. In *tetrazonia,* etc., it is narrowed towards the apex (fig. 93), in *leei,* etc., it is rounded (fig. 125), in most of the species, it is slightly emarginated (*kimminsi,* fig. 16) and in *japonica,* it has a V-shaped distal incision. Inside the genital cavity and just above the subgenital plate, there is a highly sclerotized internal skeleton. The latter shows a desired specific variability and individual constancy and has been used for identification by several authors for the past ten years. This plate is often supported by an inner pair of very dark pigmented rods or an axis. In most species, the axis is long and extends beyond the plate of the internal skeleton (*flavipennis,* etc., fig. 23), in others, it is less developed and confined by the plate (*tjederi,* etc., fig. 17), and in some others the axis is greatly reduced or absent (*japonica,* etc., fig. 100). Curiously enough, all the females of the *diceras* group have a small axis, i. e., slender and not extending beyond the plate of the internal skeleton. The above mentioned features of both male and female genital structures are constant in the individuals of each species, and show simultaneous modifications in the different species. They therefore serve as excellent characteristics for identification. The following keys to both male and female *Panorpa* are based mainly on these characteristics mentioned.

Key to the Males of Panorpa

The males of the following species are unknown: *lutea* Carpenter, *semifasciata* Cheng, *leei* Cheng, *statura* Cheng, *pusilla* Cheng, *pieli* n. sp., *bonis* Cheng, *klapperichi* Tjeder, *implicata* n. sp., *guttata* Navas, *grahamana* n. sp., *carpenteri* n. sp.

1. Sixth abdominal segment with anal horn 2
   Sixth abdominal segment without anal horn (text-fig. 2, C)..... ....(*davidi* group) 9

2. Sixth abdominal segment with double anal horn (text-fig. 2, A) ..... (*diceras* group) 3
   Sixth abdominal segment with single anal horn (text-fig. 2, B) ..... (*centralis* group) 6
3. Hypovalvae greatly broadened distally 4
   Hypovalvae slightly broadened distally 5
4. Tips of hypovalvae rounded; proximal lobes of the harpagones pointed (fig. 7) ..... *diceras*
   Tips of hypovalvae truncated; proximal lobes of the harpagones rounded (fig. 8) ..... *stotzneri*
5. Parameres four branched; preëpiproct with only shallow distal incision (figs. 1, 6) ..... *tjederi*
   Parameres three branched; preëpiproct with wide U-shaped distal incision (figs. 4, 9) ..... *kimminsi*
6. Genital bulb rounded; the outer margins of harpagones not concave at the middle 7
   Genital bulb less rounded; the outer margins of harpagones slightly concave at the middle 8
7. Coxopodites with a group of very strong black spine-like hairs on their inner apical margins; parameres simple, broad basally, abruptly tapering into a slender and acute distal portion (fig. 10) .... *centralis*
   Coxopodites without strong black spine-like hairs on their inner apical margins; parameres simple, stout, spindle-shaped (fig. 34) .... *obtusa*
8. Inner margins of harpagones without true lobes; hypovalvae rather broad, with slightly concave median outer margins; parameres long, with pointed apex, reaching to the distal part of harpagones (fig. 31) ..... *emarginata*
   Inner margins of harpagones with true lobes; hypovalvae very slender, with even outer margins; parameres short, with blunt apex, reaching only to the base of harpagones (fig. 11) ..... *flavipennis*
9. Wing membrane deeply yellow 10
   Wing membrane faintly yellow or hyaline 12
10. Wing markings distinct; basal band absent or represented by two separated spots 11
    Wing markings indistinct; basal band well developed, extending from subcostal to the anal margin of wing, broadened towards its posterior end; 6th to 8th abdominal segments as in figure 78 ..... *tincta*
11. Pterostigmal band absent; apical band broad, smoky brown; harpagones long and slender; hypandrium conspicuous, slender (fig. 33) ..... *stigmalis*
    Pterostigmal band present, with complete basal branch and separated apical branch; apical band interrupted; harpagones short; hypandrium conspicuous, broad (figs. 48, 277) ..... *waongkehzengi*

12. Pterostigmal band present but interrupted 13
Pterostigmal band present, not interrupted 14
13. Hypandrium rather conspicuous; apical processes of aedeagus very long, with greatly enlarged distal ends (fig. 46) ..... *difficilis*
Hypandrium inconspicuous; apical processes of aedeagus long, with narrow tooth-like distal ends and double sinuous outer margins (fig. 38) ..... *fructa*
14. Pterostigmal band with complete basal branch; apical branch absent 15
Pterostigmal band with both basal branch and apical branch..... 19
15. Basal band complete, not interrupted 16
Basal band interrupted, represented by two spots 17
16. Marginal spot present; inner margin of harpagones with a smooth median angle, a basal true lobe and a very large basal concave area (figs. 51, 284) ..... *cladocerca*
Marginal spot absent; inner margin of harpagones with a sharp median angle and a basal lobe which does not arise at the same level as the former (figs. 49, 283) ..... *trifasciata* n. sp.
17. Marginal spot present, and prominent; inner margin of harpagones with a smooth median angle and a broad basal lobe (fig. 59)..... ..... *flavicorporis* n. sp.
Marginal spot greatly reduced or absent; inner margin of harpagones with a sharp median angle and a basal lobe which arises at a different level or no true basal lobe at all 18
18. Parameres branched basally, the outer branch long, broadened towards apex; the inner branch short, with a bundle of long brown stiff hairs (fig. 86) ..... *cheni* n. sp.
Parameres simple, long and slender (fig. 57) ..... *davidi*
19. Apical branch of pterostigmal band interrupted, separated from pterostigmal band itself 20
Apical branch of pterostigmal band not interrupted, connected with pterostigmal band itself 23
20. Apical branch of pterostigmal band connected with the apical band to form a hyaline window which encloses a faintly brown spot; genital bulb as in figure 45 ..... *obliqua*
Apical branch of pterostigmal band not connected with the apical band 21
21. Harpagones very long and slender, inner margin with a broad basal lobe; hypovalvae narrow basally, very broad and robust distally; apex of preëpiproct usually folded downward, with very minute distal incision (figs. 83, 84) ..... *baohwashana* n. sp.
Harpagones short, no true basal lobe present; hypovalvae not broadened distally; apex of preëpiproct with very wide U-shaped distal incision 22

22. Parameres spindle-shaped distally; inner margin of harpagones with a sharp median tooth; apical processes of aedeagus simple (fig. 58) ..... *fukiensis*
Parameres long and slender; inner margin of harpagones with a smooth median angle; apical processes of aedeagus finger-shaped, their distal inner margins produced inwards to form a small nipple-shaped plate (figs. 36, 39) ..... *typicoides*
23. Apical branch of pterostigmal band broad, nearly the same width as the basal branch 24
Apical branch of pterostigmal band narrow, much narrower than the basal branch 26
24. Parameres simple, not branched; the distal inner margin of coxopodites with a very prominent papilla (fig. 52) ..... *curva*
Parameres Y-shaped; the distal inner margin of coxopodites without a papilla 25
25. Wing membrane light yellow, markings yellowish brown; harpagones with a long and large basal concave area; genital bulb slender, not elliptical (fig. 62) ..... *aurea* n. sp.
Wing membrane hyaline, markings sooty brown; harpagones with no concave area, but with median toothed basal lobe; genital bulb elliptical (fig. 63) ..... *coomani* n. sp.
26. Hypandrium conspicuous, appearing as a long narrow stalk; preëpiproct with rounded apex; harpagones long and slender; parameres very small, short rod-like (figs. 85. 90) ..... *japonica*
Hypandrium inconspicuous; preëpiproct with distal incision; harpagones not very long; parameres well developed 27
27. Inner margin of harpagones with prominent lobes; distal inner margin of coxopodites without prominent spines; parameres widening abruptly and giving rise to a long curved process which bears numerous long barbs (fig. 91) ..... *tetrazonia*
Inner margin of harpagones without true lobes, but with basal concave areas; distal inner margin of coxopodites with six prominent spines; parameres narrow and slender, without barbs (fig. 87) .... *sexspinosa*

Key to the Females of Panorpa

The females of the following species are unknown: *diceras* McLachlan, *obtusa* Cheng, *davidi* Navas, *curva* Carpenter, *difficilis* Carpenter, *fructa* Cheng, *coomani* n. sp., *stigmalis* Navas, *tincta* Navas.

1. Wing membrane deeply yellow 2
Wing membrane faintly yellow or hyaline or lacteous 5
2. Pterostigmal band complete, forked posteriorly 3
Pterostigmal band not complete, not forked posteriorly, apical branch

of pterostigmal band absent; apical band broad, with a large window; wing length less than 9 mm. (fig. 277) ..... *waongkehzengi*

3. Markings blackish brown, prominent; basal spot present; internal skeleton with a very short axis (fig. 112) ..... *lutea*
   Markings gray or brown; basal spot absent 4
4. Wing broad; markings brown; apical band large with a small hyaline spot (fig. 279) ..... *statura*
   Wing narrow; markings gray; apical band reduced to a few faint spots ..... *flavipennis*
5. Pterostigmal band absent 6
   Pterostigmal band present 9
6. Internal skeleton with short axis, not extending beyond the plate 7
   Internal skeleton with long axis, usually extending beyond the plate 8
7. Subgenital plate not emarginated distally; internal skeleton as in figure 18, with somewhat converging posterior arms; wing membrane with faintly yellowish tinge; tip of wing bordered with strong yellowish brown ..... *stotzneri*
   Subgenital plate slightly emarginated distally; internal skeleton as in figure 19, with somewhat diverging posterior arms; wing membrane dusky hyaline; tip of wing bordered with grayish yellow (fig. 271) ..... *kimminsi*
8. Internal skeleton as in figure 24, axis extending beyond the plate one half its length ..... *emarginata*
   Internal skeleton as in figure 20, axis extending beyond the plate less than one half its length ..... *centralis*
9. Pterostigmal band not prominent, represented only by a spot posterior to the pterostigma 10
   Pterostigmal band prominent 11
10. Wings subobtuse; apical band absent; pterostigma smoky; internal skeleton as in figure 17, with posterior arms extending parallel to each other ..... *tjederi*
    Wings narrow and slender; apical band present, interrupted, represented by three separated spots; pterostigma yellow. ..... *guttata*
11. Pterostigmal band with only basal branch 12
    Pterostigmal band with both basal branch and apical branch 19
12. Basal branch of pterostigmal band narrow 13
    Basal branch of pterostigmal band the same width as the pterostigmal band itself 15
13. Both basal band and marginal spot present; subgenital plate long and slender; internal skeleton small, as in figure 69. ..... *flavicorporis*
    Both basal band and marginal spot absent 14

14. Basal branch of pterostigmal band interrupted; internal skeleton as in figure 114 ..... *semifasciata*
Basal branch of pterostigmal band not interrupted; internal skeleton as in figure 127 ..... *leei*
15. Subgenital plate with less sclerotized lateral plates; both sides of the subgenital plate enclosed by the lateral borders of the 9th tergite 16
Subgenital plate without lateral plates; both sides of the subgenital plate are free 17
16. Rostrum brownish black in color, with an orange median longitudinal stripe; the anterior arms of the internal skeleton slightly outwardly curved as in figure 115 ..... *grahamana* n. sp.
Rostrum uniformly reddish brown, no median longitudinal stripe; the anterior arms of the internal skeleton folded transversely at its median portion as in figure 116 ..... *carpenteri* n. sp.
17. Subgenital plate slender, narrow basally; internal skeleton as in figure 68 ..... *cladocerca*
Subgenital plate somewhat triangular, broad basally 18
18. Subgenital plate with slightly emarginated apex; internal skeleton as in figure 96 ..... *cheni* n. sp.
Subgenital plate with rounded apex; internal skeleton as in figure 65 ..... *trifasciata* n. sp.
19. Apical branch of pterostigmal band interrupted, separated from pterostigmal band itself 20
Apical branch of pterostigmal band not interrupted, connected with pterostigmal band itself 27
20. Apical branch of pterostigmal band large, united with the apical band to form one or two hyaline spots 21
Apical branch of pterostigmal band small, simple, separated from the apical band 22
21. Wing membrane faintly yellow; subgenital plate with rounded posterior margin; internal skeleton as in figure 98, with short axis .... *obliqua*
Wing membrane hyaline, subgenital plate with slightly concave posterior margin; internal skeleton as in figure 103, with very long axis.... ..... *implicata* n. sp.
22. Wing membrane light yellow; fore wing length less than 11 mm. ..23
Wing membrane hyaline; fore wing length more than 12 mm. 24
23. Wing markings sooty brown; internal skeleton with small plate as in figure 118 ..... *pusilla*
Wing markings gray; internal skeleton with large plate as in figure 117 ..... *pieli* n. sp.

24. Fore wing length more than 18 mm.; subgenital plate with prominent V-shaped distal incision; internal skeleton as in figure 105, with nearly straight axis ..... *baohwashana* n. sp.
Fore wing length less than 16 mm.; subgenital plate with no prominent V-shaped distal incision; internal skeleton with outwardly curved axis 25
25. Internal skeleton with long axis, extending nearly two-thirds its length beyond the plate as in figure 67 ..... *typicoides*
Internal skeleton with short axis, extending not more than half its length beyond the plate 26
26. Apical band prominent, large; basal band complete; apex of subgenital plate not emarginated; axis of internal skeleton simple, as in figure 71 ..... *fukiensis*
Both apical band and basal band interrupted; apex of subgenital plate slightly emarginated; distal ends of the axis of internal skeleton branched as in figure 106 ..... *bonis*
27. Apical branch of pterostigmal band broad, nearly the same width as the basal branch 28
Apical branch of pterostigmal band narrow, much narrower than the basal branch 29
28. Wing membrane light yellow, markings yellowish brown; internal skeleton large, as in figure 77, with long outwardly curved axis extending beyond the plate one half its length ..... *aurea* n. sp.
Wing membrane hyaline, markings sooty brown; internal skeleton small, as in figures 120, 121, with very short axis not extending beyond the plate ..... *klapperichi*
29. Internal skeleton as in figure 100, no axis present ..... *japonica*
Internal skeleton with well developed axis 30
30. Wing membrane hyaline; internal skeleton as in figure 124, posterior arms short, pointed towards apex ..... *sexspinosa*
Wing membrane with slightly yellowish tinge; internal skeleton as in figure 94, posterior arms long, with rounded apex ..... *tetrazonia*

Descriptions of Species of Panorpa

Panorpa diceras McLachlan

Figures 2, 7

Panorpa diceras McLachlan, 1894, Ann. Mag. Nat. Hist., (6)**13**:423. Esben Petersen, 1921, Coll. Zool. Selys Long., **5**(2):36. Tjeder, 1936, Ark. för Zool., **27** A (33):9, pls. 4, 5, 7, figs. 4, 5. Carpenter, 1938, Proc. Ent. Soc. Washington, **40**(9): 270, figs. 2, 10, 11. *Id.*, 1948, Psyche, **55**(1): 28, fig. 1.

Panorpa grahami Carpenter, 1938, Proc. Ent. Soc. Washington, **40**(9):272, figs. 5, 9.

Body light brown; vertex with a black spot around ocelli; rostrum with black stripe on each side; thorax and abdomen with a lateral black stripe; sixth abdominal segment of male with two short anal horns. Fore wing: length, 11 mm.; width, 3.5 mm.; membrane hyaline without markings except for a slight suspicion of gray at the apex; neuration distinct, Sc extends to the pterostigmal area, R_2 is forked and R_1, R_3, R_4, R_5 are simple, usually one crossvein occurring between R_1 and R_2. Hind wing: similar to the fore wing. Male genitalia: genital bulb rounded; coxopodites rather long; harpagones slender, the outer margin slightly concave at the middle, the inner margin with a small distal lobe and a larger pointed proximal lobe; hypandrium inconspicuous, hypovalvae long, reaching to the base of the harpagones, narrowed proximally, much broadened distally, with rounded tips; parameres complex, each consisting of a narrow basal stalk, which gives rise to three branches, pectinately arranged, the basal branch being the shortest, the others about equal; preëpiproct with prominent distal lobes, the incision being almost quadrate.

Female unknown.

Type (♂): Tachienlu, Sikang; in McLachlan Collection.

Distribution: Tachienlu, Sikang; 9 miles south of Tachienlu, Sikang (8500-13,000 ft.), June 25-27, 1923 (D. C. Graham).

This species, which has double anal horns in the male, belongs to the *diceras* group. I have not seen the type. According to Carpenter's drawing, this species resembles *stotzneri* Esben-Petersen in general appearance. However, the rounded tips of the hypovalvae and the pointed proximal lobes of the harpagones make its recognition easy.

Panorpa tjederi Carpenter

Figures 1, 6, 12, 14, 17

Panorpa tjederi Carpenter, 1938, Proc. Ent. Soc. Washington, **40**(9):271.
Panorpa diceras Tjeder (*nec* McLachlan), 1936, Ark. för Zool., **27** A (33):9, pls. 4, 5, pl. 7, figs. 4, 5.

According to Tjeder, the body characters of the male of this species agree wholly with McLachlan's original description for *Panorpa diceras* McLachlan. In the characteristics in size, color of head, body and legs, and shape of wings, the ♀ agrees perfectly with the ♂. The color of the wings is distinctly different.

Besides the smoky pterostigma, there is a subtriangular smoky brown oblique spot, extending from the pterostigma down into the cellula between R_5 and M_{1+2} (just before the fork-point). The additional side plates of the 7th to 8th abdominal segments are wholly absent, the tergites are comparatively narrow while the sternites are very broad (with their lateral margins reaching up to the dorsal surface), and the pleural regions are very narrow and situated latero-dorsally. The detail drawings of both ♂ and ♀ genitalia were given by Tjeder. According to these drawings, the genital bulb of ♂ genitalia is oval; coxopodites rather long, U-shaped; harpagones very broad at the base but strongly tapering into a very acute and hooked, curved apex, the outer margin slightly concave at the middle, the inner margin with a median small tooth-like process and a large basal tooth directed inwards; hypandrium inconspicuous; hypovalvae slender, slightly broadened and diverging towards each other in the distal half, reaching to the base of the harpagones; parameres complex, each consisting of a narrow basal stalk, which gives rise to four branches; one of these arises inwardly from about the middle of the stalk, the others arise further distally and continue nearly straight; preëpiproct broad, narrowed towards apex, which is broadly emarginated; aedeagus smoothly emarginated distally, both apical and lateral processes inconspicuous. Female genitalia: the subgenital plate is very broad, and its lateral margins overlap the sides of the 9th tergite; at the hind margin the plate appears broad and tongue-like, extending through this tongue-like process farther backwards than the 9th tergite; internal skeleton very broad, posterior arms of the plate blunt and stout, strongly folded, leaving between them proximally a smoothly rounded space; axis short, lying wholly within the plate and ending behind the basal flaps of the plate, which are very large, and lie close to one another, with their apical ends directed upwards.

Types (♂, ♀): Yunnan (George Forrest); in K. J. Morton Collection, Edinburgh.

Distribution: same as types.

This species belongs to the *diceras* group. I have not seen the types. According to Tjeder's drawings, it is closest to *diceras* McLachlan in general appearance. However, the hypovalvae are

not broadened towards the apex as in those of *diceras*. The parameres of this species are apparently four-branched, whereas those of *diceras* are only three-branched. According to Tjeder, the wings of the female of this species show great similarity to those of *Panorpa bicornuta* McLachlan (from Japan), as figured by Esben-Petersen, but the female genitalia of this species are very different from those of *bicornuta*.

Panorpa stotzneri Esben-Petersen

Figures 8, 15, 18

Panorpa stotzneri Esben-Petersen, 1934, Vidensk. Medd. Dansk Naturh. Foren., **97**:211, figs. 1, 2. Tjeder, 1936, Ark. för Zool., **27** A (33):11, pl. 6.

Body mostly lemon-colored; vertex with a black spot, enclosing the ocelli; rostrum with two brownish-black longitudinal streaks; thorax with a black longitudinal streak along each margin; 1st to 5th abdominal segments of male lemon-colored, with a black streak along each margin, last few abdominal segments with indication of a darker color; the hind border of third tergite produced in a short lobe; sixth segment somewhat swollen, and its hind margin above produced in two club-shaped anal horns; abdomen of female yellowish, with a black streak along each side. Fore wing: length, 17 mm., membrane faintly yellowish tinged, tip of the wings strongly bordered with yellowish brown; venation blackish brown, Sc reaching to the pterostigma, which is prominent. Hind wing: length, 15 mm., similar to the fore except that Sc reaches only half way to the pterostigma. Male genitalia: according to Esben-Petersen's drawing, the genital bulb is rounded; coxopodites rather short, harpagones slender, each with pointed and inwardly curved apex, the outer margin very slightly concave at the middle, the inner margin with a sharp median tooth and a rounded proximal lobe; hypandrium inconspicuous; hypovalvae greatly broadened towards truncated apex, and nearly reaching to the base of the harpagones; parameres apparently three-branched according to Esben-Petersen's drawing, but unfortunately the structure is not completely shown. The female genitalia have been worked out by Tjeder. The additional side-plates of the 7th segment are large

and apically grown together with the 7th tergite. The additional side-plates of the 8th segment are wholly grown together with the 8th tergite, which thus appears much broader (in lateral view) behind the spiracle than before it; the 7th and 8th sternites are comparatively narrow and appear in lateral view as narrow borders only; the 9th tergite is longer than the 8th segment; subgenital plate appears broadly oval with tip slightly produced, smoothly rounded; distally the plate bears several strong black setae; internal skeleton rather large, the plate broadened near the base, posterior arms well developed, long, rounded and somewhat converging, the axis very short and situated wholly within the plate.

Type (♂): Kwanhsien, Szechwan (W. Stötzner); in Esben-Petersen's Collection, Silkeborg. Type (♀): Wolungkwan, Szechwan, 55 km. west of Kwanhsien, Szechwan and 150 km. northeast of Tachienlu, Sikang (W. Stötzner); in Staatliches Museum für Tier- und Völkerkunde, Dresden.

Distribution: same as types.

This species belongs to the *diceras* group. I have not seen the types. According to Esben-Petersen's and Tjeder's drawings, it is closest in general appearance to *Panorpa diceras* McLachlan. However, the hypovalvae, though broadened distally as in *diceras*, are truncated distally, whereas those of *diceras* have a rounded apex. The proximal lobes of the harpagones of this species are rounded, not pointed as in *diceras*. Unfortunately, Esben-Petersen's drawing of the male type does not show details of the structure of the parameres or of the aedeagus.

Panorpa kimminsi Carpenter

Figures 4, 9, 16, 19, 271

Panorpa kimminsi Carpenter, 1948, Psyche, **55**(1):29.

Panorpa diceras Carpenter (*nec* McLachlan), 1938, Proc. Ent. Soc. Washington, **40**(9):270, figs. 2, 10, 11.

Body yellow; vertex with black area in the region of the ocelli and between the antennal bases; rostrum with a black stripe along each side; eyes grayish brown; thorax and abdomen yellow, with a black stripe laterally, 6th abdominal segment of male with a pair of short anal horns, as in *diceras*. Fore wing: length, 15-18 mm.; width, 4 mm.; membrane dusky hyaline, with grayish

yellow at the apex; pterostigma deep yellow, prominent; neuration as in *diceras*. Hind wing: length, 13-15.5 mm.; width, 4 mm.; similar to fore wing. Male genitalia: genital bulb oval; coxopodites U-shaped; harpagones slender, the outer margins smoothly curved, inner margins with two teeth, a small distal one and a long, slender, proximal one; hypandrium inconspicuous, hypovalvae prominent, only very slightly broadened distally, reaching to the base of the harpagones; parameres complex, consisting of a slender basal stalk, which gives rise to three branches, a small one on the inner side, a long middle branch, which extends well up between the harpagones, and a shorter outer branch, which curves inwardly in back of (i.e., above) the second branch; preëpiproct broad, with long distal lobes; aedeagus with rounded apical processes and rounded lateral processes. Female genitalia: posterior border of subgenital plate rounded, slightly emarginated; internal skeleton small, the axis very small, not projecting beyond the plate; the plate attached to a chitinous, hood-shaped membrane, which extends slightly beyond the axis.

Holotype (♂): Mt. Omei (11,000 ft.), Szechwan, July, 1936 (D. C. Graham); in U. S. National Museum. Allotype (♀): near Tachienlu (5000-8500 ft.), Sikang, June 18- July 12, 1923 (D. C. Graham); in U. S. National Museum.

Distribution: Vicinity of Tachienlu, 30 miles north of Tachienlu (12,000 ft.), 9 miles southwest of Tachienlu (9000-11,000 ft.), Sikang, June 5-27, 1923; west of Yachow (2000-7500 ft.), Sikang, June 14-18, 1922; Omei (11,000 ft.), Szechwan, July, 1936; Suifu, Szechwan, Oct., 1929.

This species belongs to the *diceras* group. It is the most widely distributed of all the double anal horn species. It differs from the other species by the curved harpagones and the peculiar configuration of the parameres of the male. It should be noted that the structure of both the subgenital plate and the internal skeleton of the female is very similar to that of *stotzneri* Esben-Petersen.

Panorpa centralis Tjeder

Figures 5, 10, 20, 21

Panorpa centralis Tjeder, 1936, Ark. för Zool., **27** A (33):3, pls. 1, 2, 7, figs. 1, 2.

Body mostly black; vertex and frons deep black; rostrum shining dark piceous with somewhat lighter margins, apically a little darker; prothorax black with narrow yellowish side-margins, meso- and metathorax deep-black dorsally, pleura and underside of thorax reddish yellow; 1st to 6th abdominal segments of male deep black, last few abdominal segments fuscous; anal horn present, single, brownish, directed obliquely upwards; the third tergite in the middle of its hind-border develops into a very small rounded lobe; abdominal segments of female deep black, 7th and 8th segments with long narrow additional anal plates in the pleural region behind the spiracle. Fore wing: length, 13 mm.; width, 3 mm.; membrane hyaline, with a faintly whitish tinge in male, more yellowish brown in female; wings of male without markings, while those of female with spots between R_5 and M_1 and at the place where Cu_1 reaches the hind margin; pterostigma whitish, faintly indicated in male, but distinct and light-brown in female; neuration distinct; Sc extends to the pterostigmal area, R_2 is forked, and R_1, R_3, R_4, R_5 are simple; usually one crossvein between R_1 and R_2. Hind wing: length, 12 mm.; width, 3 mm.; similar to the fore. Male genitalia: genital bulb rounded; coxopodites long, with a group of strong and black, spine-like hairs on their inner apical margins; harpagones short, ending in an acute apex, bent slightly inwards, the outer margin not concave at the middle, the inner margin having a dilatation midway between base and apex; the under surface shows a distinctly rounded excavation; hypandrium inconspicuous; hypovalvae rather narrow, not reaching to the base of the harpagones, their borders straight and running parallel; along their inner margins they bear a row of long and strong black hairs, directed inwards; parameres simple and short; in their proximal part they are very broad, but a short distance behind the middle of their length they suddenly taper into a slender and acute distal portion, which on the inner margin bears a dense row of lamellae, directed obliquely inwards; preëpiproct narrowed towards apex with a U-shaped distal incision; aedeagus with very long and acute apical processes, lateral processes short, blunt tooth-like. Female genitalia: subgenital plate oval with smoothly rounded side-margins, which overlap the lower margins of the 9th tergite to a very little extent; its apex has a very small excision; in-

ternal skeleton large, but rather narrow, with a pair of short, blunt, posterior arms; on each side of the proximal part of the plate, there are three lamellae directed forwards and inwards, ending acutely and having the apices of the two inner pairs bent somewhat outwards; the axis is long, extending more than one third its length beyond the plate, the proximal ends almost unpigmented, deeply cleft and directed slightly outwards.

Holotype (♂): Pao-ning-fu (400 m.), northeast Szechwan, May 20, 1930 (D. Hummel); in Stockholm Museum. Allotype (♀): Tjeggala (3700 m.), Sept. 4, 1930 (D. Hummel); in Stockholm Museum.

Distribution: same as types.

This species, which has a single anal horn in the male, belongs to the *centralis* group. It resembles in general appearance *Panorpa cornigera* McLachlan, which belongs to the *cornigera* group, as established by Issiki. However, many parts of the male and female genitalia and especially the shape of the parameres and that of the apical processes of the aedeagus make it easily recognized as a distinct species.

Panorpa emarginata Cheng

Figures 24, 25, 27, 31, 32, 273

Panorpa emarginata Cheng, 1949, Psyche, **56**(4):140, figs. 1, 11, 12, 24, 26, 29.

Vertex entirely black; rostrum grayish brown anteriorly, yellowish brown laterally; thorax yellowish brown laterally, pronotum blackish brown, meso- and metanotum entirely pitchy black; the 1st to 6th abdominal segments pitchy black dorsally and ventrally, last few abdominal segments yellowish brown; 6th abdominal segment of male with a single anal horn, yellowish brown in color. Fore wing: length, 14 mm.; width, 3.5 mm.; membrane hyaline, without markings except for a slight suspicion of gray at the apex; pterostigma prominent, indicated by light brown color; the dorsal hind margin of wing slightly emarginated. Hind wing: length, 12.5 mm.; width, 3.5 mm.; similar to fore wing. Male genitalia: genital bulb less rounded; coxopodites long, broadened towards its apex; harpagones short, the outer margin slightly concave at the middle, inner margin

with a median small triangular tooth and a large basal concave area; hypandrium inconspicuous; hypovalvae long, with slightly concave median outer margins, extending nearly to the base of the harpagones; parameres simple and long, usually reaching to the distal part of harpagones, each consisting of a single stalk, which broadens at the middle and becomes very long and sharp distally, bearing a series of long barbs at its distal inner margin; preëpiproct narrowed towards apex, with nearly straight sides and a narrow U-shaped distal incision; aedeagus with very long apical processes and prolonged lateral processes, the distal inner margin of the former usually with a broad triangular plate. Female genitalia: subgenital plate elongated, emarginated posteriorly, the incision being very small; internal skeleton large, the plate concave at the middle, with a pair of sharp distal posterior arms and two pairs of small basal side plates; the axis long, extending beyond the plate one-half its length.

Holotype (♂): Mt. Hwa, Shensi, June, 1942 (Io Chou); in Museum of Comparative Zoology. Allotype (♀): same collecting data as holotype; in Cheng Collection, Taipeh.

Distribution: same as types.

This species, possessing a single anal horn, belongs to the *centralis* group, with the wing membrane transparent as in *centralis* Tjeder. The wing apex of *centralis* Tjeder is colorless, whereas that of *emarginata* is maculated with a slight suspicion of gray. The male genitalia differ from those of *centralis* by the less rounded genital bulb and the longer and sharper parameres.

Panorpa obtusa Cheng

Figures 28, 34, 37, 272

Panorpa obtusa Cheng, 1949, Psyche, **56**(4):142, figs. 2, 25, 27, 30.

Vertex entirely black; rostrum reddish brown, with a weakly defined grayish stripe on each side; thorax reddish brown laterally, entirely black dorsally; the 1st to 6th abdominal segments black dorsally and ventrally, last few abdominal segments of male reddish brown; the hind border of the third tergite of male prolonged into a small semicircular process, 6th abdominal segment furnished with a single anal horn, reddish brown in color.

Fore wing: length, 14 mm.; width, 3.55 mm.; membrane light grayish brown, without markings except for a slight suspicion of grayish brown at the apex; pterostigma prominent, indicated by grayish brown color; the wing apex obtuse, broader than in the preceding species. Hind wing: length, 13 mm.; width, 3.5 mm.; similar to fore wing. Male genitalia: genital bulb rounded, coxopodites long; harpagones short and stout, the outer margin smoothly curved, the inner margin with a greatly reduced median tooth (which cannot be seen from ventral view) and a large basal concave area; hypandrium inconspicuous; hypovalvae rather straight, reaching nearly to the base of the harpagones; parameres simple and stout, usually not extending beyond the tips of coxopodites, each consisting of a single spindle-shaped stalk, formed by the outer strongly sclerotized part; the distal inner margins of parameres furnished with a series of long barbs; preëpiproct slightly narrowed towards apex, with a wide U-shaped distal incision; aedeagus with small lateral processes and a pair of long apical processes, the inner margins of the latter nearly parallel to each other.

Female unknown.

Holotype (♂): Mt. Taipai, Shensi, July 14, 1943 (Chuan Lung Lee); in Cheng Collection, Taipeh.

Distribution: same as types.

This species belongs to the *centralis* group, having the same wing markings as *emarginata*, but the body color and the structure of the male genitalia, especially the short parameres, make its recognition easy.

Panorpa flavipennis Carpenter

Figures 3, 11, 13, 22, 23

Panorpa flavipennis Carpenter, 1938, Proc. Ent. Soc. Washington, **40**(9):268, figs. 3, 7, 12.

Body black; vertex entirely black; rostrum reddish brown; last few abdominal segments of male reddish brown, single anal horn on 6th abdominal segment very short, 7th segment moderately incised above. Fore wing: length, 13-14 mm.; width, 3 mm.; membrane deep yellow, markings gray; pterostigmal band usually complete or nearly so; basal band interrupted; apical

band reduced to a few faint spots; both basal and marginal spots absent; pterostigma dark red, very prominent; crossveins not margined. Hind wing: similar to fore wing, except that basal band is entirely lacking. Male genitalia: genital bulb less rounded; coxopodites rather long; harpagones slender, with the outer margins slightly concave proximally, and a pair of longer lobes distally, the ventral lobe having a smoothly curved margin, the dorsal one an abruptly curved margin; hypandrium inconspicuous, hypovalvae very slender, almost reaching to the base of the harpagones; parameres simple, each consisting of a single broad flat process bearing on its inner distal margin a number of distinct barbs; preëpiproct with curved sides and a moderately deep, U-shaped incision distally; aedeagus with rather sharp horn-like apical processes and rounded lateral processes. Female genitalia: subgenital plate slender, slightly emarginated distally; internal skeleton large, the axis extending beyond the plate for nearly half its length.

Holotype (♂): Beh-luh-din (6000 ft.), 30 miles north of Chengtu, Szechwan, Aug. 11, 1933 (D. C. Graham); in U. S. National Museum. Allotype (♀): same collecting data as holotype except for date: Aug. 8, 1933; in U. S. National Museum.

Distribution: Beh-luh-din (6000 ft.), 30 miles north of Chengtu, Szechwan; July 12 to Aug. 27.

This species, possessing a single anal horn, belongs to the *centralis* group. At present, there are four known species in this group. The wing membrane of *flavipennis* is deep yellow, whereas that of the other three species is colorless, lacteous or grayish brown. The male genitalia differ from those of the other three species in the more slender hypovalvae and the possession of distinct lobes on the harpagones.

Panorpa davidi Navas

Figure 57

Panorpa davidi Navas, 1908, Mem. Real. Acad. Cienc. Barc., 1908: 415, figs. 19a, b. Esben-Petersen, 1921, Coll. Zool. Selys Long., **5**(2):29, figs. 21-23. Carpenter, 1945, Psyche, **52**(1-2):73, pl. 10, fig. 4.

Body mostly black; vertex black, with a reddish-brown spot behind, touching the eyes; rostrum reddish brown; thorax black,

with a longitudinal median reddish streak; 1st to 6th abdominal segments of male blackish dorsally and ventrally, last few abdominal segments testaceous; the 6th segment with a small, pale, hairy notch on the dorsal tip; no true anal horn present; 7th and 8th abdominal segments much narrower than 6th and of equal length. Fore wing: length, 13 mm.; membrane hyaline, with a feeble yellowish tinge; veins brownish, the greater part of crossveins in the apical half of the wing pale; pterostigmal band complete, with only basal branch; basal band indicated by two spots; apical band rather large, with a separated spot near the hind margin of the wing; both basal and marginal spots absent; pterostigma rather prominent. Hind wing: length 11.5 mm.; similar to fore wing, except that the separated spots of the apical bands are located near the pterostigma. Male genitalia: genital bulb slender; coxopodites long, U-shaped, at the inner distal end of coxopodites giving rise to a prominent papilla, along the inner surface of which there is a row of stout hairs; harpagones small, the outer margin not concave at the middle, the inner margin no true lobe; hypandrium inconspicuous; hypovalvae slender, not reaching to the base of the harpagones; parameres slender and long, the inner surface bearing a series of short barbs.

Female unknown.

Holotype (♂): Mou-pin, Sikang, 1870 (David); in Muséum National d'Histoire Naturelle, Paris.

Distribution: same as holotype.

This species, which has no anal horn in the male, differs from the others of the *davidi* group by its elliptical genital bulb, with long and slender parameres. I have not seen this species. The drawing of the genital bulb (fig. 57) is based upon Carpenter's drawing which he made at the Muséum National in Paris in 1938. The wing markings resemble *Panorpa eheni* n. sp. However, the structure of the genital bulb is quite different from that of the latter.

Panorpa stigmalis Navas

Figures 30, 33

Panorpa stigmalis Navas, 1908, Mem. Real. Acad. Ciene. Barc., 1908: 406, fig. 20. Esben-Petersen, 1921, Coll. Zool. Selys Long., 5(2):31, figs. 27-30.

Body mostly black; vertex brown, with a blackish spot enclosing the ocelli; rostrum blackish at the apex; thorax black on the dorsum and sides; 2nd and 3rd abdominal segments black above, 2nd segment also black on the venter, the other abdominal segments brownish red; median process of the third tergite rather long, extending posteriorly and in contact with the conical projection on the caudal portion of the fourth tergite; the hind border of the 6th segment furnished with a group of short hairs dorsally and ventrally. Fore wing: length, 17 mm.; very narrow; membrane with a strong yellowish tinge, markings smoky brown; pterostigmal band absent; basal band represented by a narrow streak, extending from the place where 1A joins the hind margin to Cu_1; apical band broad; both basal and marginal spots absent; pterostigma prominent, red in color. Hind wing: length, 16 mm.; similar to the fore, except that the interrupted basal band is entirely absent. Male genitalia: genital bulb oval; coxopodites not very long; harpagones long and slender, the outer margin concave near the middle, inner margin with a basal process; hypandrium very slender, conspicuous; hypovalvae slender, with rather pointed tips, not reaching to the base of the harpagones; preëpiproct slender, with a deep U-shaped distal incision.

Female unknown.

Type (♂): Mou-pin, Sikang (David); in Muséum National d'Histoire Naturelle, Paris.

Distribution: same as type.

This species, belonging to the *davidi* group, is close to the *kongosana* group, as established by Issiki (this group comprises two known species, both of which are continental, i.e., Korean). However, the wing markings are quite different from those of the latter group. I have not seen this species. The drawings of the genital bulb and of the preëpiproct are based on Esben-Petersen's, which he made at the Muséum National in Paris. Unfortunately, his drawings of the male type show nothing of the structure of the parameres and that of the aedeagus.

Panorpa waongkehzengi Navas

Figures 43, 47, 48, 72, 73, 277

Panorpa waongkehzengi Navas, 1935, Notes d'Ent. Chin. Mus. Heude, **2**(5): 98, fig. 62.

Body mostly shining reddish yellow; vertex with a black spot between ocelli; antennae blackish brown; thorax and abdomen slightly darker dorsally. Fore wing: length, 8.3-9 mm.; width, 2.5 mm., with rounded wing apex; membrane yellowish, markings deep brown; pterostigmal band complete, with broad basal branch and a separated apical branch; basal band interrupted, represented by two prominent spots; apical band also interrupted, consisting of two anterior spots and a narrow shadow along the wing apex; basal spot absent; marginal spot prominent; pterostigma prominent, deep yellow. Hind wing: length, 7.7-8.3 mm.; width, 2.4 mm.; similar to fore wing, except that the basal band is represented by only one posterior spot. Male genitalia: genital bulb slender; coxopodites long, with narrow and truncated apex; harpagones very short, the outer margin slightly concave at the middle, inner margin swollen medially with a large cylindrical basal lobe which is concave apically to form the shape of an ear; hypandrium short, broader distally; hypovalvae narrowed towards their rounded apex, not extending near the base of the harpagones; parameres simple, each consisting of a single stalk, which is distinctly twisted and bears a row of short barbs along its inner margin; preëpiproct broad basally, abruptly narrowed towards its apex, which is slightly emarginated and bears a row of long black bristles; aedeagus large, apical processes very long with enlarged boot-shaped apex; lateral processes not prominent, slightly protruding to form a pair of triangular plates. Female genitalia: subgenital plate broad, narrowed towards apex which is slightly concave; internal skeleton large, the plate narrow basally; the posterior arms of the plate stout, pointed, the axis long, strongly sclerotized, extending beyond the plate for exactly half its length.

Types (♂, ♀): Kuling, Kiangsi, Aug. 28, 1935 (Piel); in Heude Museum, Shanghai.

Distribution: same as types.

This species, belonging to the *davidi* group, differs from other described *Panorpa* by its short harpagones and broad hypandrium of the ♂ genitalia. The peculiar structure of the internal skeleton of ♀ genitalia also makes its recognition easy. The description and drawings of both the male and the female of this species are based upon specimens labeled as paratypes, which were loaned to me by the Heude Museum, Shanghai.

Panorpa difficilis Carpenter

Figures 42, 46

Panorpa difficilis Carpenter, 1938, Proc. Ent. Soc. Washington, **40**(9):269, figs. 4, 6.

Body black; vertex with a narrow transverse black band enclosing ocelli; rostrum light brown; anal horn absent; last few abdominal segments brown. Fore wing: length, 11 mm.; width 3 mm.; membrane hyaline, markings grayish brown; pterostigmal band broad but interrupted, basal band reduced to a small spot at the origin of R_s (in type); apical band much broken; both basal spot and marginal spot absent; crossveins not margined. Hind wing: similar to the fore wing. Male genitalia: genital bulb rounded; coxopodites long; harpagones small, the outer margins slightly concave, apices abruptly curved, no true lobes present; hypandrium rather conspicuous, hypovalvae of moderate width, not reaching to the base of the harpagones; parameres simple, each consisting of a single stalk, broader distally than proximally, and with a cluster of barbs near the tip; the interior cavity of the genital bulb is unusually narrow; preëpiproct slender, with a deep U-shaped distal incision; apical processes of aedeagus very long with greatly enlarged distal end, lateral processes more or less rounded.

Female unknown.

Holotype (♂): Chengtu, Szechwan, 1936 (D. C. Graham); in U. S. National Museum.

Distribution: same as holotype.

This species, belonging to the *davidi* group, resembles *Panorpa curva* Carpenter superficially, but differs in the broader genital bulb and especially in the absence of the prominent papilla at the distal inner margin of the coxopodites.

Panorpa fructa Cheng

Figures 29, 35, 38

Panorpa fructa Cheng, 1949, Psyche, **56**(4):144, figs. 5, 6, 7.

Body mostly sooty black, last few abdominal segments of male reddish brown, vertex black anteriorly, deeply reddish brown posteriorly; rostrum uniformly reddish brown. Fore wing: length, 11.5 mm.; width, 3 mm.; membrane hyaline, markings light brown, ill-defined, fragmentary; pterostigmal band incomplete, with a spot-like basal branch; basal band represented by two spots; apical band appearing as a light suspicion of brown at the apex; basal spot very small; marginal spots large; pterostigma not very prominent. Hind wing: length, unknown; width, 3 mm.; similar to fore wing, except that the basal band and the basal spot are entirely absent. Male genitalia: genital bulb very rounded; coxopodites long, stout, with four spine-like hairs and a series of short hairs in the distal inner portions; harpagones slender, the outer margin rather straight, inner margin with a median angle and a rather large basal concave area; hypandrium inconspicuous; hypovalvae rather short, far from reaching to the base of the harpagones; parameres simple, long and twisted, the distal half well developed, with rounded apex furnished with a short spine-like tip; preëpiproct rather short, broad at the base, narrowed towards apex, with a broad U-shaped distal incision; aedeagus with long apical and lateral processes, the former with rather straight inner margins and double sinuous outer margins.

Female unknown.

Holotype (♂): Wakiakeng (50 miles west of Tachienlu), Sikang, Sept. 9, 1939 (F. Y. Cheng, Io Chou and Tein Ho Hei): in Cheng Collection, Taipeh.

This species belonging to the *davidi* group, resembles *Panorpa difficilis* Carpenter superficially, but differs in the structure of the male genitalia. In *difficilis*, the apical processes of the aedeagus have greatly enlarged distal ends, whereas in this species, the distal ends of the apical processes of the aedeagus are narrow and rather pointed.

Panorpa cladocerca Navas

Figures 41, 51, 68, 74, 284

Panorpa cladocerca Navas, 1935, Notes d'Ent. Chin. Mus. Heude, **2**(5):95, figs. 59, 60.

Vertex shining black anteriorly, chestnut brown posteriorly; rostrum uniformly shining reddish yellow; thorax black dorsally, deep yellow laterally; 1st to 5th abdominal segments of male black dorsally, reddish yellow ventrally, 6th abdominal segment black anteriorly, chestnut brown posteriorly, last few abdominal segments reddish brown; anal horn absent; abdominal segments of female black dorsally, chestnut brown ventrally. Fore wing: length, 12.5-14.5 mm.; width, 3.6 mm.; membrane hyaline, markings sooty brown; pterostigmal band broad, with same broad basal branch, but no apical branch; basal band complete; apical band large, slightly interrupted posteriorly; basal spot absent; marginal spot very small, not extending to the anterior margin of the wing; pterostigma prominent. Hind wing: length, 11.3-12.7 mm.; width, 3.4 mm.; similar to fore wing, except that the small marginal spot is absent. Male genitalia: genital bulb oval; coxopodites short, with truncated apex; harpagones slender, the outer margin slightly convex at the middle, inner margin with a median angle and a true basal lobe; basal concave area very large, same width as the harpagones and occupying two-thirds of the whole length of the latter; hypandrium inconspicuous; hypovalvae long and slender, slightly crooked at the middle, diverging from each other distally, reaching to the base of the harpagones; parameres simple, each consisting of a single stalk, with broad base and inwardly curved apex, the inner margins usually bearing a row of short barbs; preëpiproct slender, with nearly straight sides and a deep U-shaped distal incision; aedeagus prominent, apical processes short with rounded apex, lateral processes very slender, extending upward behind the basal lobe of the harpagones. Female genitalia: subgenital plate slender, slightly constricted at the middle, with wedge-shaped apex; internal skeleton small, the median portion of the plate less sclerotized, with a pair of narrow vertically erected lobes, the posterior arms of the plate rather long, pointed towards apex.

Types (♂, ♀): Kuling, Kiangsi, Sept. 4-7, 1934 (Piel): in

Heude Museum, Shanghai.

Distribution: same as types.

This species, belonging to the *davidi* group, differs from other described *Panorpa* by its unforked pterostigmal band and the complete basal band in the wing markings. The peculiar structure of both the male and the female genitalia also makes its recognition easy. The description and drawings of both the male and the female of this species are based upon specimens labeled as paratypes which were loaned to me by the Heude Museum, Shanghai.

Panorpa trifasciata n. sp.

Figures 40, 49, 50, 64, 65, 283

Body mostly black; vertex sooty brown with black mark enclosing ocelli; rostrum uniformly grayish brown; thorax light brown laterally, sooty brown dorsally; the 1st to 5th abdominal segments of male piceous black dorsally, 6th segment twice as long as preceding segment, uniformly black, last few abdominal segments nearly same length as the 6th, reddish brown in color, the hind border of the third tergite slightly produced; the 1st to 6th abdominal segments of female blackish brown dorsally and ventrally, last few abdominal segments reddish brown. Fore wing: length, ♂, 13.2 mm., ♀, 15 mm.; width, ♂, 3.1 mm., ♀, 3.6 mm.; membrane hyaline, markings sooty brown; pterostigmal band broad, basal branch of the pterostigmal band well developed, as broad as pterostigmal band so as to form a broad transverse band; apical branch of pterostigmal band absent; basal band complete; apical band prominent; both basal and marginal spots absent; pterostigma very prominent. Hind wing: length, ♂, 12 mm., ♀, 13.5 mm.; width, ♂, 3 mm.; ♀, 3.5 mm.; similar to fore wing, except that the basal band is not so developed. Male genitalia: genital bulb oval; coxopodites long and stout with truncated apex and a row of long spine-like bristles on its distal inner margin; harpagones slender, the outer margin slightly smoothly curved, inner margin with a sharp median angle and a basal lobe which does not arise at the same level as the former; hypandrium short; hypovalvae straight, slender, with rounded apex, not extending near to the base of harpagones; parameres

simple, narrowed towards apex, their whole inner margin bearing dense and long blackish brown, spine-like bristles; the median portion of parameres usually covered by the aedeagus in ventral view; preëpiproct broad, abruptly narrow at the apical portion with deep U-shaped distal incision; aedeagus large, the apical processes tooth-like, lateral processes well developed, long, rod-shaped with swollen apex, extended upward and reaching to the median portion of the harpagones. Female genitalia: subgenital plate rather long, narrowed towards apex with folded margins on its basal portion; internal skeleton small, the median portion of the plate swollen to form a pair of thick margins; posterior arms of the plate narrowed towards apex; no axis present.

Holotype (♂): Ta-chu-lan, Shaowu Hsien, Fukien, Nov. 7, 1943 (Maa); in Museum of National Foochow University, Foochow. Allotype (♀): Sien-feng-ling, Shaowu Hsien, Fukien, Oct. 15, 1941 (Maa); in Maa Collection. Paratypes: 4 ♀♀, same collecting data as holotype; 2 ♂♂, 1♀, Kuatun, Chungan Hsien, Fukien, Aug. 22-Oct. 29, 1942-1945 (Maa and Lin), in Maa Collection; 1♂, 1♀, same collecting data as holotype, in Museum of Comparative Zoology; 2 ♂♂, 3 ♀♀, same collecting data, in Cheng Collection, Taipeh.

This species belongs to the *davidi* group and resembles *Panorpa cladocerca* Navas in the wing markings. However, in *cladocerca,* the wing has more extensive markings and the marginal spot is always present, whereas in *trifasciata,* the three bands of the wing are much narrower than those of *cladocerca* and the marginal spot is absent. The genitalia of *trifasciata* differ from those of *cladocerca* by the peculiar basal lobes of the harpagones of the male and the triangular-shaped subgenital plate of the female.

Panorpa flavicorporis n. sp.

Figures 59, 60, 69, 75, 80

Body yellowish brown; vertex deep brown with slightly blackish-brown mark enclosing ocelli; rostrum uniformly light brown; thorax slightly blackish-brown dorsally, meso- and metanotum with a very broad, light brown streak; the 1st to 5th abdominal

segments of male slightly blackish brown dorsally, last few abdominal segments yellowish brown; the 1st to 6th abdominal segments of female blackish brown dorsally, last few segments yellowish brown. Fore wing: length, ♂, 12.3 mm., ♀, 14.2 mm.; width, ♂, 3.1 mm., ♀, 3.5 mm.; membrane hyaline, markings sooty brown; pterostigmal band complete with narrow basal branch, apical branch not developed; basal band much restricted medially, separated into two spots; apical band large, interrupted posteriorly; basal spot very small; marginal spot prominent; pterostigma not very prominent. Hind wing: length, ♂, 11 mm., ♀, 12.5 mm.; width, ♂, 3.1 mm., ♀, 3.5 mm.; similar to fore wing, except that the basal band is represented only by one spot and both basal and marginal spots are entirely lacking. Male genitalia: genital bulb slender; coxopodites long, with truncated apex; harpagones slender, the outer margin smoothly curved, inner margin with a median angle and a broad basal lobe; hypandrium short; hypovalvae with narrow, blunt apex, reaching far beyond to the base of the harpagones; parameres simple, very long with broad base and twisted apical portion, extending nearly to the apex of harpagones; preëpiproct broad, narrowed towards apex with broad U-shaped distal incision; aedeagus large, the apical processes horn-like, extending outward, lateral processes appearing as a pair of lobes. Female genitalia: subgenital plate long and slender, with folded, narrow, membranous margins and wedge-shaped distal end; internal skeleton very small, the plate rather broad, the posterior arms of the plate narrowed towards apex, the axis small, slightly projecting beyond the plate.

Holotype (♂): Ta-chu-lan, Shaowu Hsien, Fukien, Oct. 21, 1943 (Maa); in Museum of National Foochow University, Foochow. Allotype (♀): Hwang-keng, Kienyang Hsien, Fukien, Oct. 11, 1943 (Maa); in Maa Collection. Paratypes: 8 ♂ ♂, 16 ♀ ♀, same collecting data as holotype; 1 ♂, 2 ♀ ♀, Kienyang Hsien, Fukien, Oct. 17-31, 1942 (Maa), in Maa Collection; 2 ♂ ♂, 2 ♀ ♀, Riu-tun, Kienyang Hsien, Fukien, Oct. 15, 1941 (Maa and Lin), in Museum of Comparative Zoology; 2 ♂ ♂, 4 ♀ ♀, same collecting data, in Cheng Collection, Taipeh.

This species, belonging to the *davidi* group, resembles *Panorpa davidi* Navas in the wing markings. However, in this species,

the marginal spot of the wing is prominent, whereas that of *davidi* is absent. The harpagones of the male genitalia of this species have broad basal lobes, whereas those of *davidi* are absent. The yellowish body color and the peculiar structure of the female genitalia also make its recognition easy.

Panorpa cheni n. sp.

Figures 56, 86, 88, 95, 96

Body brown; vertex blackish brown, with small black mark enclosing ocelli; rostrum uniformly light brown; thorax blackish brown dorsally, light brown laterally; the 1st to 5th abdominal segments of male blackish brown dorsally, light brown ventrally. 6th segment long, cylindrical, blackish brown, last few segments light brown, the hind border of the third tergite slightly produced; 1st to 6th abdominal segments of female black dorsally and ventrally, last few segments light brown. Fore wing: length, ♂, 11.7 mm., ♀, 13.5 mm.; width, ♂, 2.9 mm., ♀, 3.5 mm.; membrane hyaline, markings sooty brown; pterostigmal band complete, basal branch of pterostigmal band broad, the outer margin of the latter with hyaline area, apical branch absent; basal band represented by two narrow spots; apical band present; basal spot absent; marginal spot very small and sometimes absent; pterostigma not very prominent. Hind wing: length, ♂, 10.7 mm., ♀, 12.5 mm.; width, ♂, 2.8 mm., ♀, 3.5 mm.; similar to fore wing, except that the basal band is entirely lacking. Male genitalia: genital bulb oval; coxopodites long, with truncated apex; harpagones slender, the outer margin slightly concave at the middle, inner margin with a prominent tooth-like process and a large true basal lobe which does not arise at the same level; hypandrium inconspicuous; hypovalvae narrow and slender, divergent, not extending near the base of the harpagones; parameres branched basally, the outer branch long, broadened towards apex, with knob-shaped distal end; the inner branch short, with a bundle of long, stiff brown hairs; preëpiproct broad, slightly narrowed towards apex, with U-shaped distal incision; aedeagus with prominent ventral processes and twisted rod-shaped apical processes, lateral processes absent. Female genitalia: subgenital plate triangular, with slightly emarginated

apex; internal skeleton small, the median part of the plate a little swollen, less sclerotized with a very short axis, the posterior arms of the plate long and slender, narrowed towards the apex.

Holotype (♂): Tien-mu-shan, Chekiang, July 27, 1936; in Museum of Institute of Zoology, Academia Sinica, Shanghai. Allotype (♀): Tien-mu-shan, Chekiang, Aug. 17, 1935; same type location as holotype. Paratypes: 1♀, same collecting data and same type location as allotype; 1♀, same collecting data, in Museum of Comparative Zoology; 1♂, 1♀, same collecting data, in Cheng Collection, Taipeh.

I take the liberty to name this species in honor of Dr. Sieien H. Chen who has been so kind as to loan me the material from the Museum of the Institute of Zoology, Academia Sinica, Shanghai.

This species, belonging to the *davidi* group, resembles *Panorpa davidi* Navas and *P. flavicorporis* n. sp. in the wing markings, but is quite different in both the male and the female genitalia. The parameres of the male genitalia of both *davidi* and *flavicorporis* are simple, whereas those of *cheni* are branched. The subgenital plate of the female genitalia of *flavicorporis* is long and slender, whereas that of *cheni* is triangular.

Panorpa obliqua Carpenter

Figures 44, 45, 97, 98

Panorpa obliqua Carpenter, 1945, Psyche, **52**(1-2):70, pl. 10, figs. 2, 3, 8; pl. 11, fig. 9.

Body brown; vertex dark brown; thoracic nota and abdominal tergites very dark brown; anal horn of male absent. Fore wing: length, 12 mm.; width, 3.5 mm.; membrane faintly yellow, markings blackish brown; pterostigmal band complete with rather narrow basal branch and a separated apical branch, the latter connected with the apical band to form a hyaline window which encloses a faint, brown spot; basal band represented by two spots, the large one, situated on the anal margin of wing, is very large with a hyaline window; apical band large, usually united with the apical branch of pterostigmal band, and within its area, there are two hyaline bands and one large hyaline window; basal spot appears as a transverse band along the

anal margin of the wing; marginal spot elongated, band-like, united with the basal branch of pterostigmal band to form a V-shaped marking; pterostigma prominent; crossveins not marginated. Hind wing: similar to fore wing in markings, except that the left "arm" of the "V" is usually interrupted. Male genitalia: genital bulb rounded, coxopodites long, U-shaped; harpagones short, outer margins slightly concave; prominent lobes on inner margin of the harpagones near the base; hypandrium rather long, conspicuous; hypovalvae short, close to each other at the middle of the genital bulb, and extending slightly beyond the base of the harpagones; parameres simple, each consisting of a slightly flattened process, with a few short barbs on the inner surface distally, and terminating in a longer series of barbs directed inwards; preëpiproct much narrower distally, with a pair of broad terminal lobes, close together. Female genitalia: subgenital plate with rounded posterior margin; internal skeleton large, with two long, slender distal processes and a pair of large, ear-like flaps laterally; the usual axis is short, but there is a very slender median process extending posteriorly.

Holotype (♂): Hong San, Southeast Kiangsi, June 28, 1936; in Museum of Comparative Zoology. Allotype (♀): Hong San, Southeast Kiangsi, June 29, 1936; in Museum of Comparative Zoology.

Distribution: same as types.

This strikingly marked species, belonging to the *davidi* group, is easily recognized by the oblique stripe traversing the middle of the wing, and extending posteriorly and distally from the anterior margin. The short hypovalvae of the male genital bulb are unique among the known Chinese species of *Panorpa,* but are very much like those of certain Japanese, Siberian and Formosan species (e.g., *Panorpa preyeri* McLachlan, *wormaldi* McLachlan, and *peterseana* Issiki), to which *obliqua* Carpenter is undoubtedly closely related.

Panorpa implicata n. sp.

Figures 99, 103, 280

Body mostly black; vertex entirely black; rostrum rather short, uniformly reddish brown; thorax pale-white laterally,

sooty brown dorsally; the 1st to 9th abdominal segments of female deep brown dorsally and ventrally. Fore wing: length, 13.5 mm.; width, 3.2 mm.; membrane hyaline, markings sooty brown, similar to the preceding species; pterostigmal band complete with broad basal branch and a separate large apical branch, the latter with a hyaline spot and connected with the apical band to form another hyaline spot; basal band represented by two spots; the one situated on the anal margin of wing is very large and includes a hyaline spot; apical band large, usually united with the apical branch of pterostigmal band, and within its area there are one large hyaline spot and two hyaline bands; basal spot appears as a transverse band along the anal margin of wing; marginal spot elongate, band-like, united with the basal branch of pterostigmal band to form a V-shaped marking; pterostigma prominent. Hind wing: length, 12 mm.; width, 3.1 mm.; similar to the fore. Female genitalia: subgenital plate broadened medially with slightly concave apex; internal skeleton large, the plate bearing paired, folded, side plates; the posterior arms of the plate crooked, narrowed towards apex, the axis long, extending beyond the plate for exactly half its length.

Male unknown.

Holotype (♀): Ta-chu-lan, Shaowu Hsien, Fukien, May 15, 1945 (Maa); in Museum of National Foochow University, Foochow. Paratypes: 2 ♀ ♀, same collecting data as holotype; 1 ♀, Tsi-li-chiao, Chungan Hsien, Fukien, May 1, 1943 (Maa), in Maa Collection; 1 ♀, same collecting data as holotype, in Museum of Comparative Zoology; 1 ♀, Kuatun, Chungan Hsien, Fukien, May 11, 1942 (Maa), in Cheng Collection, Taipeh.

This species resembles *Panorpa obliqua* Carpenter in the wing markings, but differs in the female genitalia. The subgenital plate of *obliqua* has a rounded posterior margin, whereas that of *implicata* is slightly concave. The axis of the internal skeleton of *obliqua* is short, whereas that of *implicata* is long. The position of this species in the above grouping is not determined.

Panorpa baohwashana n. sp.

Figures 82, 83, 84, 101, 105, 285

Body mostly black; vertex uniformly deep black; rostrum uni-

formly brownish black; thorax mostly black dorsally, reddish brown laterally; the 1st to 9th abdominal segments of both sexes black dorsally and ventrally, the hind border of the third tergite of male produced into a short process, and in contact with the small, very sharp conical projection on the median fourth tergite, the 6th to 8th segments prolonged, usually longer than the 5th segment. Fore wing: length, 18-20 mm.; width, 5 mm.; membrane hyaline, markings brownish black; pterostigmal band complete, with broad basal branch and very narrow and separated apical branch; basal band represented by two spots; apical band very large; basal spot absent; between the basal area and the basal band, there are two additional small spots; marginal spot small, not extending to the anterior margin of wing; pterostigma not very prominent. Hind wing: length, 16.5-18.5 mm.; width, 4.5 mm.; similar to fore wing, except that the basal band is represented by only one spot, the two additional spots between the basal area and the basal band are entirely absent, and the marginal spot not well developed. Male genitalia: genital bulb slender; coxopodites long, with truncated apex; harpagones very slender, outer margin deeply concave basally, smoothly curved distally, inner margin with three small lobes; the outer margin folded upward, the apex folded inward to form a rounded distal end which reaches to the base of the harpagones; parameres simple, each consisting of a single stalk, which is broader distally than basally and bears on its distal inner margin a row of short barbs; preëpiproct slender, the basal portion broad, oval; the distal portion narrow, the apex with very minute distal incision usually folded downward; aedeagus with prominent ventral processes, apical processes long with folded apical portion, extending above the basal lobes of harpagones, lateral processes finger-like, extending upward. Female genitalia: subgenital plate broader distally than basally, with small V-shaped distal incision, the median longitudinal line of the subgenital plate less sclerotized; internal skeleton with long and stout axis, the plate long and narrow, occupying the area between the two axes, the posterior arms of the plate well-developed, with sharp apex.

Holotype (♂): Bao-hwa-shan, Kiangsu, July 16, 1942; in Museum of Institute of Zoology, Academia Sinica, Shanghai. Allotype (♀): Same collecting data and same type location as

holotype. Paratypes: 4 ♂ ♂, 5 ♀ ♀, same collecting data as holotype, in same type location as holotype; 2 ♂ ♂, 2 ♀ ♀, same collecting data as holotype, in Museum of Comparative Zoology; 2 ♂ ♂, 3 ♀ ♀, same collecting data; 3 ♂ ♂, 2 ♀ ♀, N. Han-nu-shan, July 16, 1940, in Cheng Collection, Taipeh.

This species, belonging to the *davidi group,* resembles *Panorpa approximata* Esben-Petersen, which is in the *amurensis* group, as established by Issiki (this group comprises four known species, all of which are known as continental, i.e., E. Siberia and Korea), but differs in several respects. Esben-Petersen's drawing of the male genitalia of *approximata* shows that the hypandrium is rather long and the distal end of the preëpiproct is only slightly emarginated. The distal part of the hypandrium of this new species is deeply cleft to form the narrow bases of the hypovalvae; the distal end of the preëpiproct has a narrow U-shaped distal incision. Unfortunately, according to Esben-Petersen, the type of *approximata* (♂) lacks the parameres, so I cannot compare the genital structures of these two species in detail.

Panorpa typicoides Cheng

Figures 26, 36, 39, 66, 67, 276

Panorpa typicoides Cheng, 1949, Psyche, **56**(4): 143, figs. 3, 13, 14, 28, 31.

Body mostly black; vertex black anteriorly, brown posteriorly; rostrum entirely brown; thorax black dorsally, yellowish brown laterally, meso- and metanotum with a broad brown median band; 1st to 6th abdominal segments of male black dorsally and ventrally, last few abdominal segments reddish brown, anal horn absent; the hind border of third tergite slightly prolonged behind, and in contact with the small, sharp conical production on the median axis of the 4th tergite; abdominal segments of female entirely black. Fore wing: length, 12.5 mm.; width, 3 mm.; membrane hyaline, markings sooty brown; pterostigmal band complete, with a broad basal branch and a separated narrow apical branch; basal band interrupted, represented by two large spots; apical band broad, with a large hyaline spot posteriorly; basal spot very small; marginal spot large, not extending beyond the vein R_1; pterostigma brown, very prominent. Hind wing: length, 11.5 mm.; width, 3.3 mm.; similar to fore wing, except that the basal spot and the anterior part of the basal band are

entirely lacking. Male genitalia: genital bulb rounded; coxopodites long, U-shaped, furnished with a series of long hairs at the distal inner portion; harpagones slender, the outer margin slightly concave at the middle, inner margin with a median angle and a small basal concave area; hypandrium inconspicuous; hypovalvae rather long, reaching to the base of the harpagones; parameres simple and slender, each consisting of a single stalk, which is distinctly twisted and pointed at its apex; preëpiproct slender, slightly narrowed towards apex, with a deep U-shaped distal incision; aedeagus with finger-shaped apical processes and slightly prolonged lateral processes, the distal inner margins of the former usually produced inwards to form a small nipple-shaped plate. Female genitalia: subgenital plate elongated, broadened at the middle; internal skeleton long, the plate narrowed towards its base with a pair of sharp posterior arms, the axis very long, extending nearly two-thirds its length beyond the plate.

Holotype (♀): Tachienlu (5000-8500 ft.), Sikang, Aug. 27, 1939 (F. Y. Cheng, Io Chou and Tein Ho Hei); in Museum of Comparative Zoology. Allotype (♀): same collecting data as holotype; in Cheng Collection, Taipeh.

Distribution: same as types.

This species, belonging to the *davidi* group, resembles the common European species *Panorpa communis* Linné and *P. fukiensis* Tjeder in the wing markings, but differs in the structure of the male genitalia. The parameres of *communis* are very broad, lobe-shaped; those of *fukiensis* are spindle-shaped, whereas those of *typicoides* are narrow and slender, thread-like.

Panorpa fukiensis Tjeder

Figures 54, 58, 70, 71

Panorpa fukiensis Tjeder, 1950, Bonn Zool. Beitr., 1950 (2-4):286, figs. 1, 2.

Head blackish brown; rostrum yellowish brown; thorax blackish brown dorsally, yellowish brown laterally, the meso- and metanotum with light brown across their hind parts; 1st to 5th abdominal segments of male blackish brown dorsally; 6th segment blackish brown in the upper part and faintly yellow in the lower part, no anal horn present; 7th and 8th segments long and narrow, of the same length; abdomen of female long and slender,

blackish brown, a little lighter at the basal portion; apex of the abdomen light brown; additional side plates of the 7th and 8th segments very narrow, 9th tergite long. Fore wing: length, ♂, 14 mm.; ♀, 16 mm.; width, ♂, 3.3 mm.; ♀, 3.8 mm.; membrane hyaline, markings blackish brown; veins whitish; pterostigmal band distinct, with broad basal branch and separated narrower apical branch; basal band broad, complete; apical band broad, interrupted posteriorly, connected with the pterostigmal band anteriorly; basal spot absent; marginal spot present; pterostigma rather prominent. Hind wing: length, ♂, 12.5 mm.; ♀, 14 mm.; width, ♂, 3 mm.; ♀, 3.5 mm.; similar to fore wing. Male genitalia: genital bulb elliptical; coxopodites long, with more or less truncated apex; harpagones slender, the outer margin smoothly curved, inner margin with broad tooth-like projection, the median tooth located ventrally; hypandrium narrow, conspicuous; hypovalvae short, reaching about the middle of the coxopodites, slightly diverging from each other; parameres simple, spindle-shaped distally, each with eleven long, strong barbs on its inner edge and the same number of slightly narrower barbs at its apex; preëpiproct narrow, with almost parallel edges and a deep U-shaped distal incision; aedeagus with long finger-like apical processes and ax-shaped lateral processes. Female genitalia: subgenital plate long, narrowed towards apex; internal skeleton large, the outer margins slightly concave at the middle, with a pair of sharp posterior arms; axis well-developed, outwardly curved at their proximal ends, extending beyond the plate for about one-third its length.

Holotype (♂): Kwangtseh, Fukien, Sept. 25, 1937 (J. Klapperich); in Zool. Reichsinstitut and Museum A. Koenig. Allotype (♀): Kwangtseh, Fukien, Oct. 9, 1937 (J. Klapperich); same type location as holotype.

Distribution: same as types.

This species, belonging to the *davidi* group, resembles *Panorpa typicoides* Cheng in the wing markings, but the shape of the genital segments of both the male and the female make it a distinct species.

Panorpa curva Carpenter

Figures 52, 53

Panorpa curva Carpenter, 1938, Proc. Ent. Soc. Washington, **40**(9):269, figs. 1, 8.

Body black; vertex with a transverse black band, enclosing the ocelli; rostrum light reddish brown; anal horn absent; last few abdominal segments reddish brown. Fore wing: length, 7 mm.; width, 3 mm.; membrane hyaline, markings grayish brown; both basal and marginal spots absent; basal, pterostigmal and apical bands complete, the last with a few interrupted spots; crossveins not margined. Hind wing: similar to the fore wing. Male genitalia: genital bulb rather long; coxopodites very long, deep U-shaped; at the inner distal margins of coxopodites, there is a very prominent papilla bearing a number of black hairs and giving rise proximally to a large black spine; harpagones small, the outer margins slightly concave near the middle, the apices abruptly curved; no true lobes present; hypandrium inconspicuous; hypovalvae rather slender, not reaching to the base of the harpagones; parameres simple, each consisting of a single stalk, which is distinctly twisted and bears distally a cluster of short barbs; preëpiproct slender, with nearly straight side and a deep U-shaped distal incision; apical processes of aedeagus very long and slender, the outer margins abruptly convex near the middle, the lateral processes short, horn-like.

Female unknown.

Holotype (♂): 0-er (9000 ft., 26 miles north of Li-fan), Sikang, Aug. 6, 1916 (D. C. Graham); in U. S. National Museum.

This species, belonging to the *davidi* group, resembles *Panorpa davidi* Navas superficially. However, the parameres of this species are distinctly twisted distally, whereas those of *davidi* are not so. The outer margins of the harpagones of *curva* are slightly concave at the middle, whereas those of *davidi* are not concave at all.

Panorpa aurea n. sp.

Figures 55, 61, 62, 76, 77, 281

Body yellowish brown; vertex brown anteriorly with sooty brown mark enclosing ocelli, yellowish brown posteriorly with

three narrow longitudinal streaks; rostrum uniformly yellow; thorax yellow laterally, meso- and metanotum deep brown anteriorly, yellowish brown posteriorly; the 1st to 5th abdominal segments of male and female brown dorsally, last few abdominal segments yellowish brown, the hind border of the third abdominal tergite of male slightly produced. Fore wing: length, ♂, 15.5 mm., ♀, 16.3 mm.; width, ♂, 4 mm., ♀, 4.2 mm.; membrane light yellow, markings yellowish brown; pterostigmal band complete with same broad basal branch and apical branch; basal band broad, complete; apical band large, with a faint and small window; both basal and marginal spots are very small; pterostigma not prominent. Hind wing: length, ♂, 14.5 mm., ♀, 14.7 mm.; width, ♂, 3.7 mm., ♀, 4 mm.; similar to fore wing except that both basal and marginal spots are entirely lacking. Male genitalia: genital bulb slender; coxopodites long with truncated apex; harpagones slender, the outer margin slightly concave basally, smoothly curved distally, inner margin with a median small angle and a long and large basal concave area; hypandrium short; hypovalvae slender with rounded apex, not extending near the base of the harpagones; parameres long, Y-shaped, the outer branch crooked, the inner branch straight; preëpiproct long with deep U-shaped distal incision; aedeagus elongated, the apical processes long and sharp, lateral processes short, lobe-shaped. Female genitalia: subgenital plate long with wedge-shaped distal end; internal skeleton large, the plate constricted medially to form the proximal and distal oval portions, the posterior arms of the plate narrowed towards apex, the axis long, with broad base, extending beyond the plate for exactly half its length.

Holotype (♂): Kuatun, Chungan Hsien, Fukien, Oct. 28, 1942 (Maa); in Maa Collection. Allotype (♀): Kwantseh Hsien, Fukien, Sept. 23, 1943 (Maa); in Museum of National Foochow University, Foochow. Paratypes: 1 ♀, same collecting data as allotype, in Museum of National Foochow University; 4 ♀ ♀, same collecting data as holotype; 4 ♀ ♀, Ta-chu-lan, Shaowu Hsien, Fukien, Oct. 14-28, 1942 (Maa), in Maa Collection; 1 ♂, 1 ♀, Ta-chi-lan, Shaowu Hsien, Fukien, Sept. 2-Nov. 28, 1942 (Maa), in Museum of Comparative Zoology; 1 ♂, 1 ♀, same collecting data, in Cheng Collection, Taipeh.

This species, belonging to the *davidi* group, differs from other

described *Panorpa* by its golden body color and the peculiar structures of both the male and the female genitalia.

PANORPA COOMANI n. sp.

Figures 63, 79, 282

Body dull brown; vertex deep brown, with black mark enclosing ocelli; rostrum dull brown, on each of its sides a black longitudinal stripe which narrows towards distal end; thorax deep brown dorsally, meso- and metanotum with black marking on each side; the 1st to 3rd abdominal segments of male slightly blackish brown dorsally, the rest of segments reddish brown, 6th to 8th segments much prolonged, the hind border of the 3rd tergite slightly produced. Fore wing: length, 11.3 mm.; width, 3 mm.; membrane hyaline, markings sooty brown; pterostigmal band complete, with broad basal branch and apical branch; basal band interrupted medianly; apical band large, with a large hyaline spot; both basal and marginal spots present; pterostigma prominent. Hind wing: length, 10.5 mm.; width, 2.8 mm.; similar to fore wing, except that the basal spot is not so well developed. Male genitalia: genital bulb elliptical; coxopodites long, with truncated apex; harpagones slender, the outer margin not concave at the middle, inner margin with a median angle and a median toothed lobe; hypandrium very short; hypovalvae narrow and slender, not extending near the base of the harpagones; parameres Y-shaped, the inner branch very narrow, the outer branch broader and longer with a row of short barbs on its distal inner margin; preëpiproct broad basally, narrow distally, with deep V-shaped distal incision; aedeagus elongated, the apical processes long, finger-like, lateral processes short, extended downward, just opposite to the direction of the apical processes.

Female unknown.

Holotype (♂): Ku-ling, Kiangsi, Sept. 18, 1945; in Heude Museum, Shanghai.

I take the liberty to name this species in honor of Father De Cooman, who has been so kind as to loan me the material from the Heude Museum.

This species, belonging to the *davidi* group, differs from other described *Panorpa* by its small body size and the peculiar structure of the male genitalia.

Panorpa japonica Thunberg

Figures 85, 90, 100, 104, 286

Panorpa japonica Thunberg, 1784, Nov. Ins. Sp. Dissert., **3**:67, fig. 9. Burmeister, 1839, Handb. Ent., **2**:957. Westwood, 1846, Trans. Ent. Soc. London, 1846:188. McLachlan, 1868, Journ. Linn. Soc., **9**:256. *Id.*, 1875, Trans. Ent. Soc. London, 1875: 183. Miyake, 1908, Bull. Coll. Agr. Imp. Univ. Tokyo, 1908:1. *Id.*, 1913, Journ. Coll. Agr. Imp. Univ. Tokyo, 1913: 347, pl. 30, fig. 14, pl. 35, figs. 1, 2, 3, 4, 5, 6. Esben Petersen, 1921, Coll. Zool. Selys Long. **5** (2):43, figs. 45, 46.

Panorpa macrogaster McLachlan, 1868, Journ. Linn. Soc., 1868:257. *Id.*, 1875, Trans. Ent. Soc. London, 1875:184.

Panorpa leucothyria Navas, 1908, Mem. Real. Acad. Cienc. Barcelona, 1908:414.

Panorpa dyscola Navas, 1908, Mem. Real. Acad. Cienc. Barcelona, 1908:420.

Panorpa rectifasciata Miyake, 1908, Bull. Coll. Agr. Imp. Univ. Tokyo. 1908:5, pl. 1, figs. 10, 10a, 10b. *Id.*, 1913, Journ. Coll. Agr. Imp. Univ. Tokyo, 1913:350, pl. 30, fig. 16, pl. 35 figs. 7, 8.

Panorpa niphonensis Miyake, 1908, Bull. Coll. Agr. Imp. Univ. Tokyo, 1908:7, pl. 1, figs. 3, 3a, 3b.

Panorpa pulchra Miyake, 1908, Bull. Coll. Agr. Imp. Univ. Tokyo, 1908:8, pl. 1, fig. 4. *Id.*, 1913, Coll. Agr. Imp. Univ. Tokyo, 1913:349, pl. 30, fig. 17, pl. 35, figs. 4, 7, 9.

Panorpa sinanoensis Miyake, 1909, Bull. Coll. Agr. Imp. Univ. Tokyo, 1909:4, pl. 1, figs. 7, 7a, 7b.

Panorpa hageni Navas, 1909, Rev. Russe d'Ent., **9**:276.

Panorpa irregularis Miyake, 1910, Journ. Coll. Agr. Imp. Univ. Tokyo, 1910:198, pl. 11, figs. 7, 7a, 7b.

Panorpa japonica subsp. *macrogaster* Miyake, 1913, Journ. Coll. Agr. Imp. Univ. Tokyo. 1913:348.

Aulops interrupta Navas, 1913, Rev. Russe d'Ent., **13**:283, fig. 11.

Body mostly deeply black, often shining; the hind border of third abdominal tergite of male produced into a short and broad lobe, 6th abdominal segment cylindrical, 7th segment as long as 6th, but thinner, and its posterior angles somewhat produced, forming a triangular tooth; 8th segment much longer than 7th, slightly thickened towards the apex, which is obliquely truncate above; no anal horn present. Fore wing: length, 15-19 mm.; broad, with rounded tips; membrane with slightly yellowish tinge, markings sooty black; pterostigmal band complete, with a very broad basal branch and a very narrow apical branch; in

some specimens, the latter is absent, or present either as a complete, curved streak or as a spot at the hind margin; apical band very broad, the inner margin somewhat concave; in some specimens the pterostigmal band and the apical band may be traversed longitudinally by a pale line between each of the longitudinal veins; in the apical band these pale lines are divided by the darker crossveins; basal band either as a complete, oblique band or as one or two separated spots; basal spot mostly absent, but in some strongly marked specimens, a basal spot, sometimes isolated and sometimes connected with the basal band; marginal spot present mostly, but usually a little separated from the margin; pterostigma not very prominent; veins blackish brown. Hind wing: length, 14-18 mm.; similar to the fore. Male genitalia: genital bulb oval; coxopodites not very long; harpagones long and slender, the outer margin smoothly curved, inner margin more or less uneven; the median tooth is very close to the base of the harpagones, the basal lobe very small and triangular; hypandrium conspicuous, appearing as a long narrow stalk; hypovalvae narrow, short and thick, usually divergent from each other, nearly reaching to the base of the harpagones; parameres simple, short rod-like; preëpiproct tongue-shaped, with rounded apex; aedeagus with a pair of peculiar, weakly sclerotized, hairy, flattened structures and a pair of strongly sclerotized club-shaped processes; lateral processes of the aedeagus not distinct. Female genitalia: subgenital plate rather long, with V-shaped distal incision; internal skeleton small, long U-shaped, the plate not highly sclerotized, with a rounded anterior margin, axis not present.

Type: Japan; in Zool. Mus. Univ. Upsala.

Distribution: Tien-tseun, China; Gifu, Japan, April-May 1886; Yokoama, Japan; Higo, 1906, Japan; Kumamoto, Japan, April 17, 1913.

This species, belonging to the *davidi* group, is very common in Japan. Issiki has established a *japonica* group which included this species, *Panorpa klugi* McLachlan, *P. nipponensis* Navas and *P. obscura* Miyake. Apparently *japonica* resembles in general appearance these three Japanese species. However, the wing membranes of *klugi* and *nipponensis* are strongly yellowish and that of *obscura* is ochraceous yellow, whereas that of *japonica* is

only slightly yellow. The male genitalia of *japonica* also show some differences from those of the other three allied species. It is interesting to note that the aedeagus of the male and the internal skeleton of the female of *japonica* are similar to those of most *Neopanorpa*.

Panorpa tetrazonia Navas

Figures 91, 92, 93, 94

Panorpa tetrazonia Navas, 1935, Notes d'Ent. Chin. Mus. Heude, **2**(5):96, fig. 61. Carpenter, 1945, Psyche, **52**(1-2):71, pl. 10, figs. 1, 5, 6; pl. 11, fig. 10.

Body light to dark brown; vertex black anteriorly, light brown posteriorly; the thoracic nota and abdominal tergites being somewhat darker than the rest of the body; anal horn of male absent. Fore wing: length, 12-13 mm.; width, 3-3.5 mm.; membrane faintly yellow, markings brown; pterostigmal band complete, with broad basal branch and a narrow apical branch; apical band interrupted posteriorly and usually with a few small clear spots around the crossveins; basal band complete but slender; basal spot present; marginal spot elongate; crossveins not margined. Hind wing: similar to the fore, except that the basal band is interrupted and the basal spot is absent. Male genitalia: genital bulb oval; coxopodites long, U-shaped; harpagones moderately long, the outer margin not concave, inner margin with prominent lobe; hypandrium inconspicuous; hypovalvae broad and short, not extending as far as the bases of the harpagones; parameres conspicuous, each arising from a very slender stalk which widens abruptly and gives rise to a long curved process; the wide head of the stalk and the curved process bear numerous long barbs; preëpiproct with a shallow distal concavity; apical processes of aedeagus rather long, with narrower distal ends; lateral processes very short. Female genitalia: subgenital plate slender; internal skeleton with broad plate and short axis, posterior arms slender, slightly convergent distally.

Holotype (♂): Kuling, Kiangsi; in Heude Museum, Shanghai.

Distribution: Kuling, Kiangsi; Taiping-shien, Anhwei, Oct. 1932 (G. Liu); Huang-shan (few miles southwest of Taiping-shien, Anhwei).

This species, belonging to the *davidi* group, differs from all the formerly described *Panorpa* by its genital structures. The parameres of the male are most unusual, as is also the form of the internal skeleton of the genital segment of the female.

Panorpa sexspinosa Cheng

Figures 81, 87, 89, 123, 124, 278

Panorpa sexspinosa Cheng, 1949, Psyche, **56**(4):145, figs. 4, 8, 9, 15, 16.

Vertex yellowish brown, with four black spots on its anterior region, one small spot enclosing the median ocelli anteriorly, one around the other two ocelli posteriorly, the other two are on both sides of the former two spots; rostrum uniformly yellowish brown; thorax blackish brown dorsally, light yellow laterally, meso- and metanotum as a rule with broad median light yellowish streaks; abdominal segments blackish brown dorsally, light brown ventrally, the hind part of 6th abdominal segment of male and its last few abdominal segments yellowish brown, the hind border of the third tergite with a band-like prolongation. Fore wing: length, 12 mm.; width, 3 mm.; membrane hyaline, markings blackish brown; pterostigmal band complete, with a broad basal branch and a narrow apical branch; basal band unusually broad; apical band complete, with a hyaline spot; basal spot very small; pterostigma not very prominent. Hind wing: length, 10.8 mm.; width, 3 mm.; similar to fore wing, except that the basal spot is lacking. Male genitalia: genital bulb rounded; coxopodites long, with six spines on its distal inner margin; harpagones slender, the outer margin smoothly curved, inner margin with a reduced median angle and a large basal concave area; hypandrium inconspicuous; hypovalvae rather short, not nearly reaching to the base of the harpagones; parameres narrow and slender, each consisting of a single stalk which is somewhat twisted and pointed at its tip; preëpiproct slender, the distal incision being almost quadrate; apical processes of aedeagus somewhat prolonged on its distal outer margins, lateral processes well-developed. Female genitalia: subgenital plate elongate, slightly emarginate posteriorly; internal skeleton large, the plate distinctly concave at its base, with a pair of sharp posterior arms and a pair of anterior side plates; axis well-developed, extending beyond the plate for nearly one-third its length.

Holotype (♂): Mt. Taipai, Shensi, June, 1942 (Io Chou); in Cheng Collection, Taipeh. Allotype (♀): same collecting data as holotype; in Museum of Comparative Zoology.

Distribution: same as types.

This species, belonging to the *davidi* group, differs from the formerly described *Panorpa* in its wing markings; the basal band is as broad as in *Panorpa cladocerca* Navas, but its pterostigmal band is quite different. The structure of the male genitalia, especially the six spines on the distal coxopodites, makes its recognition easy.

Panorpa tincta Navas

Figure 78

Panorpa tincta Navas, 1931, Rev. Acad. Ciene. Madrid, **26**:75, fig. 13.

Vertex black; rostrum dull yellow; thorax black; abdomen tawny yellow ventrally, black dorsally with fine dull yellow hairs on the straight posterior border of the tergites; 6th abdominal segment cylindrical, brownish yellow, somewhat narrowed towards apex where it is obliquely cut off dorsally; 7th segment narrow at the base, cylindrical and black in color dorsally, with a sudden swelling near the middle, the upper border of the swollen part being slightly concave, the tip oblique, the lower border convex basally and somewhat concave towards the middle; 8th segment, with narrow cylindrical base, gradually enlarges, the upper border being at first concave and then slightly convex, while the lower border is almost straight. Fore wing: length, 15 mm.; apex elliptically rounded; membrane yellow, markings dark rust colored, indistinct; pterostigmal band complete with connecting basal branch and apical branch; basal band well-developed, extending from the subcostal to the anal margin of the wing and broadened towards the posterior end; apical band complete, sinuous on its inner margin; basal spot absent; marginal spot present; veins black in color; pterostigma rather prominent, dirty yellowish. Hind wing: length, 13.5 mm.: similar to the fore, except that the basal band and the marginal spot are absent. The ♂ genitalia have not been worked out. However, according to Navas' original description, the preëpiproct ("upper cerci" of Navas) is long, slender and bowed;

the hypovalvae ("lower cerci" of Navas), oblong, with rounded tips, are almost in contact with each other and have nearly parallel margins.

Female unknown.

Type (♂): Hweihsien, Kansu; M. H.; in Hamburg Museum.

Distribution: same as type.

This species, having a deep yellow wing membrane, belongs to the *davidi* group. It differs from the other species with yellow wing-membranes by its indistinct wing markings and the well-developed basal band. The shape of the 6-8th abdominal segments also makes its recognition easy. I have not seen this species. The above description is based upon Navas' original description.

Panorpa lutea Carpenter

Figures 107, 112

Panorpa lutea Carpenter, 1945, Psyche, **52**(1-2):72, pl. 10, fig. 7, pl. 11, fig. 11.

Body reddish brown; darker brown on vertex, thoracic nota and abdominal tergites. Fore wing: length, 15 mm.; width, 3.5 mm.; membrane deep yellow or orange, markings blackish brown; pterostigmal band complete, with broad basal branch and broad apical branch; apical band separated by a wide hyaline stripe into a large anterior apical area and a small posterior spot; basal band complete and very broad; basal spot present; marginal spot rectangular; crossveins not margined; Hind wing: similar to fore wing. Female genitalia: subgenital plate broad; internal skeleton small, with a very short axis and convergent posterior processes.

Male unknown.

Holotype (♀): Huang-shan, Anhwei (G. Liu); in Museum of Comparative Zoology.

Distribution: Huang-shan, Anhwei; Kinhua-shan, Anhwei, Oct. 1932.

This species, which is not determined in the above grouping, is unlike any other described *Panorpa* in the deep yellow color of the wings, which have the basal spot present and a complete, forked pterostigmal band.

Panorpa klapperichi Tjeder

Figures 120, 121, 126

Panorpa klapperichi Tjeder, 1950, Bonn Zool. Beitr., 1950 (2-4):289, figs. 3, 4.

Head blackish brown, rostrum light brown; pronotum blackish brown, meso- and metanotum light brown with darker spots at the bases of the fore and hind wing; abdomen blackish brown dorsally, slightly lighter ventrally, the apex of the abdomen yellowish brown; additional side plates of the 7th and 8th segments large; 9th tergite long and broad, its lateral borders bent ventrad to embrace the side borders of the subgenital plate. Fore wing: length, 13 mm.; width, 3.5 mm.; membrane hyaline, markings blackish brown; veins yellowish; pterostigmal band complete, with broad basal branch and narrower apical branch; apical band large, with two or three indistinct small windows; basal band narrow; both basal spot and marginal spot present; pterostigma prominent. Hind wing: length, 11.5 mm.; width, 3.5 mm.; similar to fore wing, except that the basal band is interrupted, represented only as a spot at the hind margin of the wing and the basal spot is entirely absent. Female genitalia: according to Tjeder's drawings, the subgenital plate is long and narrow, concave at the middle, the apex slightly concave; internal skeleton very small, located at the posterior half of the subgenital plate, posterior arms narrowed towards apex, the axis extremely small and obliquely placed, so that their proximal ends point obliquely upward, the proximal ends not extending beyond the plate.

Male unknown.

Holotype (♀): Kwangtseh, Fukien, Oct. 9, 1937 (J. Klapperich); in Museum A. Koenig, Bonn.

This species, which I have not seen, differs from all the formerly described species by the internal skeleton, which is very small in proportion to the subgenital plate and also by the peculiar small axis. The position of this species in the above grouping is not determined.

Panorpa semifasciata Cheng

Figures 113, 114, 122, 274

Panorpa semifasciata Cheng, 1949, Psyche, **56**(4):146, figs. 19, 20, 21, 53.

Body entirely sooty black; vertex black; rostrum uniformly black; the middle part of the 8th abdominal tergite slightly prolonged into a band-like extension, the 9th tergite very broad, its lateral borders bent ventrad to embrace the posterior part of the subgenital plate in ventral view. Fore wing: length, 14 mm.; width, 3.5 mm.; membrane light yellow, markings sooty brown; pterostigmal band incomplete, with an interrupted narrow basal branch; apical band small, with two hyaline spots; pterostigma prominent. Hind wing: length, 12.8 mm.; width, 3 mm.; similar to fore wing, except that the basal branch of pterostigmal band is greatly reduced. Female genitalia: subgenital plate broad, with strongly sclerotized median part and less sclerotized narrow borders, apex of subgenital plate protruded, rounded, less sclerotized, furnished with several long hairs; the sides of the plate are enclosed by the well-developed 9th tergite as mentioned above; internal skeleton flattened, the plate very small, less sclerotized; the posterior arms of the internal skeleton very long, sharp and strongly sclerotized, the anterior arms flattened, joined with the posterior arms and extending a little beyond the plate.

Male unknown.

Holotype (♀): Jihti (30 miles east of Tachienlu), Sikang, Sept. 1, 1939 (F. Y. Cheng, Io Chou and Tein Ho Hei); in Cheng Collection, Taipeh.

This species differs from all the formerly described species by its black body color, reduced wing markings and the peculiar shape of the genital segment of the female. The position of this species in the above grouping is not determined.

Panorpa leei Cheng

Figures 125, 127, 275

Panorpa leei Cheng, 1949, Psyche, **56**(4):147, figs. 17, 18, 54.

Vertex black; rostrum reddish brown, with a short and deep brown stripe on each side of its upper portion; thorax black dorsally, yellowish brown laterally; 1st to 6th abdominal seg-

ments black dorsally and ventrally, the 7th to 9th abdominal segments very small, reddish brown. Fore wing: length, 14 mm.; width, 4 mm.; membrane hyaline, markings sooty brown; pterostigmal band broad, with a complete basal branch and a greatly reduced spot-shaped apical branch; apical band small, including a prominent narrow band and some faintly smoky spots; pterostigma prominent. Hind wing: length, 13 mm.; width, 3.55 mm.; similar to fore wing, except that the basal branch of pterostigmal band is greatly reduced. Female genitalia: subgenital plate small, narrowed posteriorly, apex rounded; internal skeleton long, the plate abruptly narrow at the base, with a pair of sharp posterior arms, the axis extending for nearly half its length beyond the plate.

Male unknown.

Holotype (♀): Mt. Taipai, Shensi, July 14, 1943 (Chuan Lung Lee); in Museum of Comparative Zoology.

This species differs from all the formerly described species by its wing markings and the peculiar shape of the genital segment of the female. The position of this species in the above grouping is not determined.

Panorpa grahamana n. sp.

Figures 108, 115

Body mostly black; vertex black; rostrum brownish black, with an orange median longitudinal stripe; the 9th abdominal tergite very broad, its lateral borders bent ventrad to embrace the margins of the subgenital plate in ventral view. Fore wing: length, 13 mm.; width, 3.3 mm.; membrane hyaline, markings sooty brown; pterostigmal band broad, with a broad basal branch, but no apical branch; basal band interrupted, represented as a large spot, extended to the hind margin of the wing; apical band broad, a little interrupted anteriorly; both basal and marginal spots absent; pterostigma rather prominent. Hind wing: length, 12 mm.; width, 3.2 mm.; similar to fore wing, except that the basal band is entirely absent. Female genitalia: subgenital plate slender, tongue-shaped, with strongly sclerotized median part and less sclerotized narrow lateral plates; apex of subgenital plate rounded, less sclerotized, furnished with some prominent

hairs; the sides of the plate enclosed by the well-developed 9th tergite; internal skeleton flattened, with long posterior arms which are narrowed towards apex, anterior arms of the plate slightly outwardly curved.

Male unknown.

Holotype (♀): Suifu, Szechwan, (D. C. Graham); in Museum of Comparative Zoology.,

This species is named in honor of D. C. Graham. It is close to *Panorpa semifasciata* in the female genitalia, but differs greatly in the wing markings. The apex of the subgenital plate of this species is broadly rounded, whereas that of *semifasciata* is protruded and narrowly rounded. The position of this species in the above grouping is not determined.

PANORPA CARPENTERI n. sp.

Figure 116

Body mostly black; vertex black; rostrum uniformly reddish brown; the 9th abdominal tergite very broad, its lateral borders bent ventrad to embrace the margins of the subgenital plate in ventral view. Fore wing: length, 13.2 mm.; width, 3.2 mm.; membrane hyaline, markings sooty brown; pterostigmal band broad, with a broad basal branch, but no apical branch; basal band represented as a small spot; apical band broad, interrupted posteriorly; both basal spot and marginal spot absent; pterostigma rather prominent. Hind wing: length, 12 mm.; width, 3.2 mm.; similar to fore wing, except that the basal branch of pterostigmal band is narrower than that of the fore wing and the basal band is entirely absent. Female genitalia: subgenital plate slender, tongue-shaped, with strongly sclerotized median part and less sclerotized narrow lateral plates, apex of subgenital plate rounded, less sclerotized, furnished with some prominent hairs; the sides of the plate enclosed by the well-developed 9th tergite; internal skeleton flattened, the plate greatly reduced, with very long and sharp posterior arms and well-developed anterior arms; the latter are folded transversely right at its median portion.

Male unknown.

Holotype (♀): foot of Mt. Wa (6000-7000 ft.), Szechwan, July 27, 1925 (D. C. Graham); in Museum of Comparative Zoology.

This species is named in honor of Professor F. M. Carpenter, who has been so kind to me. It resembles the preceding species in both body color and wing markings, but differs in the color of the rostrum and the anterior arms of the internal skeleton of the female genitalia. The position of this species in the above grouping is not determined.

Panorpa statura Cheng

Figures 109, 110, 279

Panorpa statura Cheng, 1949, Psyche, **56**(4):148, figs. 32, 33, 34, 57.

Vertex blackish brown anteriorly, with a black mark within the ocelli, light brown posteriorly, with a median and a pair of longitudinal bands; rostrum uniformly reddish brown; thorax entirely brown laterally, prothorax blackish brown dorsally, meso- and metanotum uniformly blackish brown; 1st to 4th abdominal segments of female blackish brown dorsally, brown ventrally, last few abdominal segments entirely brown. Fore wing: length, 16.5 mm.; width, 4.55 mm.; membrane deeply yellowish brown, markings deep brown; pterostigmal band complete, with a broad basal branch and a broad apical branch; basal band interrupted; apical band large, with a hyaline spot; basal spot absent; marginal spot very small; pterostigma not very prominent. Hind wing: length, 15 mm.; width, 4.2 mm.; similar to fore wing, except that the small marginal spot is lacking. Female genitalia: subgenital plate elongated, narrowed posteriorly, shallowly emarginated at its apex, its lateral borders bent to form a narrow ridge; internal skeleton long, the plate concave on its median sides with a pair of short tooth-like posterior arms; the axis long, extending beyond the plate for exactly half its length.

Male unknown.

Holotype (♀): Mt. Taipai, Shensi, July 14, 1943 (Chuan Lung Lee); in Cheng Collection, Taipeh.

This species, having a yellowish brown wing membrane, differs from *Panorpa flavipennis* Carpenter by its very long wing and the markings of the apical band. The peculiar shape of the genital segment of the female makes its recognition easy. The position of this species in the above grouping is not determined.

Panorpa pusilla Cheng

Figures 118, 119

Panorpa pusilla Cheng, 1949, Psyche, 56(4):149, figs. 37, 38, 52.

Vertex yellow anteriorly, with a black spot enclosing ocelli, sooty brown posteriorly, with a median quadrangular plate; rostrum uniformly yellow; thorax brownish yellow dorsally, yellow laterally, meso- and metanotum with sooty brown markings on each side; abdominal segments sooty brown dorsally, yellow laterally and ventrally. Fore wing: length, 10.8 mm.; width, 2.8 mm.; membrane light yellow, markings sooty brown; pterostigmal band complete, with a complete basal branch and a separated apical branch; basal band complete; apical band represented by two prominent bands, the inner one narrow, being parallel to the pterostigmal band, the outer one running along the wing apex; basal spot situated on the hind margin of wing; marginal spot very large; pterostigma not very prominent. Hind wing: length, 9.5 mm.; width, 2.8 mm.; similar to fore wing, except that the basal spot on the hind margin of wing is entirely lacking. The venation of both fore and hind wings identical; Sc, as usual, does not extend to the pterostigmal area, R_1 is forked and R_2 is simple, no crossvein between R_1 and R_2. Female genitalia: subgenital plate elliptical, with a slightly distal emargination; the plate of the internal skeleton small, the posterior arms of the plate large, twisted at the middle, the axis short and slender, not extending beyond the plate.

Male unknown.

Holotype (♀): Mt. Taipai, Shensi, June, 1942 (Io Chou); in Museum of Comparative Zoology.

This species, having a light yellowish wing membrane differs from the other described *Panorpa* by its very small body size, wing markings and the peculiar shape of the genital segment of the female. The position of this species in the above grouping is not determined.

Panorpa pieli n. sp.

Figures 111, 117

Body yellowish white; vertex brown, with small grayish brown mark enclosing ocelli; rostrum yellowish white, with brownish

yellow longitudinal stripe on each side; thorax yellowish white. meso- and metanotum with yellowish brown mark on each side; the whole abdomen of female brownish yellow dorsally. Fore wing: broad basally, rounded apically; length, 11 mm.; width 3.2 mm.; membrane yellowish white, markings gray; pterostigmal band complete, with a basal branch and a separated apical branch; basal band represented by two spots; apical band represented by an inner spot and an outer band which is enclosed by the wing apex; basal spot absent; marginal spot elongated; pterostigma not prominent. Hind wing: length, 10 mm.; width, 3.2 mm.; similar to fore wing, except that the basal band is represented by only one spot. The venation of fore and hind wings identical, in both pairs of wings Sc, as usual, not extending to the pterostigmal area; R_1 is forked and R_2 is simple, no crossvein between R_1 and R_2. Female genitalia: subgenital plate broad, with a wide V-shaped distal incision; internal skeleton small, the plate rather broad, with long posterior arms which are pointed towards apex; the axis short and slender, not extending beyond the plate.

Male unknown.

Holotype (♀); Ku-ling, Kiangsi, Aug. 18, 1943 (Piel); in Heude Museum, Shanghai.

The material was collected by Dr. Piel, in honor of whom I name the species.

This species resembles *Panorpa pusilla* Cheng in body size, wing venation and wing markings. It is evident that they are closely allied; but the differences in the structure of the genitalia and in the color of the vertex and rostrum are so conspicuous that there is good reason to distinguish it as a good species. The position of this species in the above grouping is not determined.

Panorpa bonis Cheng

Figures 102, 106

Panorpa bonis Cheng, 1949, Psyche, **56**(4):150.

Panorpa cornigera Tjeder (*nec* McLachlan), 1936, Ark. för Zool. **27A** (33):7, pl. 3, pl. 7, fig. 3.

The body characters of this species agree wholly with the

original description for *Panorpa cornigera* McLachlan according to Tjeder. The wing-photo of this species is exactly the same as that of the ♀ type of *cornigera* (given by Esben-Petersen) as Esben-Petersen agreed. The detail drawings of ♀ genitalia were given by Tjeder. According to these drawings, the subgenital plate is oval with smoothly rounded side-margins, which slightly overlap the lower margins of the 9th tergite and its apex is very shallowly emarginated; the internal skeleton large but slender, the two inner pairs of the plate prominent, their proximal part appearing to end straight; posterior arms of the plate with acute distal ends; axis long, extending more than one third its length beyond the plate.

Male unknown.

Holotype (♀): Lu-pa-sze (at river Tao-ho, about 2750 m.) South Kansu, July 11, 1930 (D. Hummel); in Stockholm Museum.

Distribution: same as type.

This species resembles *Panorpa cornigera* McLachlan superficially, but differs in the structure of the female genitalia. The additional lateral plates of the 7th-8th abdominal segments of this species are not so slender as those of *cornigera*. The subgenital plate is pointed at its posterior part and shallowly emarginate at its apex, while that of *cornigera* is rounded and not emarginate. The internal skeleton of this species is quite distinct from that of *cornigera:* the plate of the former is slender with a small proximal part and short posterior arms, while that of the latter is broad, with a well-developed oval proximal part and long pointed posterior arms. The axis of this species extending beyond the plate is less than half the length of the whole axis, while that of *cornigera* usually extends beyond the plate more than half its length. The position of this species in the above grouping is not determined.

Panorpa guttata Navas

Panorpa guttata Navas, 1908, Mem. Real Acad. Cienc. Barcelona, 1908:416. fig. 19c. Esben-Petersen, 1921, Coll. Zool. Selys Long. 5(2):32, fig. 32.

Panorpa davidi (♀) Navas, 1908, Mem. Real Acad. Cienc. Barcelona, 1908: 415, fig. 19c (*nec davidi* Navas, figs. 19a, b).

Head and rostrum grayish testaceous; vertex with a blackish

spot between the ocelli; thorax and abdomen pale castaneous dorsally, pale grayish yellow ventrally. Fore wing: length, 12.5 mm.; membrane hyaline with a faint yellowish tinge; pterostigmal band indicated by a spot posterior to the pterostigma; apical band represented as three faint spots; pterostigma prominent, yellowish; veins brownish. Hind wing: length, 11 mm.; similar to fore wing, except that the faint apical band is absent.

Male unknown.

Type (♀): Mou Pin, Tibet, 1870 (David); in Muséum National d'Histoire Naturelle, Paris.

Distribution: same as type.

This species resembles *Panorpa tjederi* (♀) in the pterostigmal band of the fore wing, but differs in the presence of its apical band. The wings of *tjederi* are subobtuse, whereas those of *guttata* are very narrow and slender. However, a thorough examination of the genitalia of the female type would be highly desirable. The position of this species in the above grouping is not determined.

Genus NEOPANORPA Weele

Neopanorpa Weele, 1909, Notes Leyden Mus. **31**:4. Esben-Petersen, 1913, Notes Leyden Mus. **35**:226. *Id.*, 1921, Coll. Zool. Selys Long. **5**(2):73.
Campodotecnum Enderlein, 1910, Zool. Anz., **35**:391. *Id.*, 1912, Notes Leyden Mus. **34**:235.

Rostrum long and slender; tarsal claws serrated on inner margins; wings are fully developed, rather narrow, especially at the base; 1A short, extending to the anal margin of wing before origin of the radial sector; abdomen in both sexes not longer than the wings; 6th to 8th abdominal segments of male normal, not much prolongated; genital bulb of male not peduculate basally.

Genotype: *Neopanorpa angustipennis* Westwood.

This genus, common in southeast Asia, includes forty known species in the whole world. Nineteen species have been already recorded in China and eleven new ones are described below, making a total of thirty. They are distributed throughout nine provinces. Since no *Neopanorpa* have been found in North China (Shensi, Kansu) and Korea, I presume therefore that this genus is restricted to North Asia. The limit seems to be approximately along latitude 40°.

The most obvious difference between *Neopanorpa* and *Panorpa* is the length of 1A, as indicated in the key for the family Panorpidae. However, differences are also apparent in the 3rd abdominal tergite and in both male and female genitalia. In the male of *Neopanorpa* the median process of the 3rd abdominal tergite tends to be longer and more slender than that of *Panorpa*. In most of the species of *Neopanorpa,* this process extends to the middle of the 4th tergite or beyond the hind border of the latter (the only exception is *claripennis,* the process of which is not much prolonged and appears as a semicircular lobe). In most species of *Panorpa,* this process is not distinct, only prolonged into a small semicircular lobe (the only exception is *stigmalis,* the process of which extends to the hind portion of the 4th tergite but not beyond the hind border of the latter). In the male of *Neopanorpa* the hypovalvae are broad, mostly overlapping each other distally, whereas those of *Panorpa* are slender, never overlapping each other distally. The parameres of *Neopanorpa* are mostly absent or reduced to a short slender thread-like rod, sometimes branched, without barbs or hairs, and partly or wholly fused with the aedeagus, whereas those of *Panorpa* are well developed, prominent and mostly with barbs or hairs on their inner margins, absolutely free from the aedeagus. The only exception is *japonica* which has reduced rod-shaped parameres and is close to those of *Neopanorpa.* The aedeagus of male *Neopanorpa* is mostly very small, and the paired apical processes are short, almost united together, whereas those of *Panorpa* are very prominent, the two apical processes being very long and wide apart from each other (except in the *diceras* group, the aedeagus of which has united and short apical processes). The preëpiproct of most male *Neopanorpa* has a rounded distal margin (*heii* etc., fig. 156); in some species it is slightly emarginated (*translucida* n. sp., fig. 223), and in others it has distal processes which are directed inward towards the interior of the bulb (*pilosa,* fig. 192, *taoi,* fig. 159). In *Panorpa,* the preëpiproct has a deep U-shaped distal incision, although in *waongkehzengi* it is slightly emarginate and in *japonica* rounded. This again shows that *japonica* is close to *Neopanorpa.* In the female of *Neopanorpa,* the subgenital plate is deeply emarginate distally (except that of *kwangtsehi* n. sp., which is truncated), whereas that of *Panorpa*

has either a rounded apex or is slightly emarginate; the only exception is in *japonica*, in which the subgenital plate is as deeply emarginate as that of the *Neopanorpa*.

The larva of *Neopanorpa* has very short setae, whereas that of *Panorpa* has much longer setae. The larval head sutures of *Neopanorpa* are usually accompanied by a broadly sclerotized band, while those of *Panorpa* are simple. Moreover, along the posterior margin of the 10th abdominal segment of the larval *Neopanorpa* there are numerous hairs, absent in *Panorpa*.

The characteristics which have been used for the specific identification of *Neopanorpa* are the median process of the 3rd abdominal tergite of the male and the wing markings and both the male and female genitalia. In some species the median process of the 3rd tergite of the male is very short, far from reaching to the middle of the fourth tergite (*claripennis*, fig. 132); in others it is very long, extending far beyond the hind border of the 6th abdominal segment (*choui*, fig. 155). The color of wing membrane is useful. In some species, the wings are hyaline (*nigritis*, fig. 287), in others, they are deep yellow (*caveata* n. sp., fig. 290) and in some others, they are faintly yellow (*cavalerici*). The markings of the wings are different from species to species. In *claripennis*, *taoi*, *pilosa*, *nigritis* and *validipennis*, there are no markings at all. In *apicata* only a shadow of dark appears at the wing apex. In *choui* and *kwangtschi* n. sp., the markings are very indistinct, while in some others they are sooty brown and very extensive (*cantonensis* n. sp., fig. 302).

As in the genus *Panorpa*, both the male and the female genitalia of *Neopanorpa* remain perfectly stable even in the minute details. The general structures of both sexes are just the same as those of *Panorpa*. In the male of *Neopanorpa*, the outer margins of the harpagones are mostly concave at the middle (*caveata* n. sp., etc., fig. 133); in others they are distinctly convex (*taoi*, fig. 157, *pilosa*, fig. 193). The hypandrium is usually long and broad (*caveata* n. sp., etc., fig. 133), but in *nigritis* and *choui*, it is very inconspicuous. The hypovalvae are mostly short and broad, usually tending to overlap each other distally (*claripennis*, etc., fig. 136), but in some species, they are narrow and slender (*nigritis*, fig. 191, *mutabilis* n. sp., fig. 141). The parameres are absent in most of the species (*hcii* etc., fig. 162), in others, they are small and rod-shaped (*claripennis*, etc., fig. 136) and in

some others, they are branched (*pilosa,* etc., fig. 193). In the female of *Neopanorpa*, the subgenital plate is distinctly emarginate distally. This emargination is diversely shaped in different species. In *parva,* etc., it is wide and deep (fig. 184). In *pulchra,* etc., it is slightly concave (fig. 182). In *translucida* n. sp., etc., it is V-shaped (fig. 197). In *banksi,* etc., it is U-shaped (fig. 177), and in *kwangtschi* n. sp., it is exceptionally truncated, without emargination at all (fig. 198). The internal skeleton of the female *Neopanorpa* is usually U-shaped, with the axis absent, but in *caveata* n. sp. *nigritis, choui, kwangtschi* n. sp., *translucida* n. sp., *pielina, mutabilis* n. sp. and *maai* n. sp., the axis is prominent and projects beyond the plate of the internal skeleton. The following keys to both male and female *Neopanorpa* are based upon the characteristics mentioned above.

Key to the Males of Neopanorpa

The males of the following species are unknown: *dimidiata* Navas, *banksi* Carpenter, *parva* Carpenter, *pulchra* Carpenter, *latipennis* Cheng, *varia* Cheng, *chaoi* n. sp., *cantonensis* n. sp., *kwangtsehi* n. sp., *carpenteri* n. sp.

1. Wing membrane deep yellow 2
   Wing membrane slightly yellow or hyaline 4
2. Apical band large, with four hyaline spots; hypovalvae stout, the inner margins rather straight, the distal portions slightly separated from each other (figs. 133, 290) ..... *caveata* n. sp.
   Apical band smaller, with one or two hyaline spots; hypovalvae overlapping each other distally 3
3. Preëpiproct with a small U-shaped distal incision; the outer margins of the hypovalvae concave at the middle, inner margins straight, each with a proximal lobe (fig. 134) ..... *tienmushana* n. sp.
   Preëpiproct almost truncated; the outer margin of the hypovalvae smoothly curved, inner margins without the proximal lobe (fig. 135) ..... *hyangshana* n. sp.
4. Wings without color markings 5
   Wings with color markings 9
5. Median process of third abdominal tergite very short, not extending to middle of the fourth tergite; preëpiproct with truncated apex ..... *claripennis*
   Median process of third abdominal tergite rather long, usually extending beyond the middle of the fourth tergite; preëpiproct not truncated at the apex 6

6. The outer margins of harpagones convex near the base, basal lobe with two tooth-like processes; prëpiproct with a pair of long distal processes 7
The outer margins of harpagones not convex at all, basal lobe rounded, without a tooth-like process; prëpiproct without the long distal processes 8
7. Parameres simple, leaf-shaped; the outer margins of hypovalvae convex basally (fig. 157) ..... *taoi*
Parameres branched, both branches thread-like; the outer margins of the hypovalvae concave at the middle (fig. 193) ..... *pilosa*
8. Hypandrium short, inconspicuous; hypovalvae slender, less sclerotized and curved inward distally, separating each other, not reaching to the base of the harpagones (fig. 191) ..... *nigritis*
Hypandrium long, conspicuous; hypovalvae broad, overlapping each other, with slender basal stalk, extending far beyond the base of the harpagones (fig. 145) ..... *validipennis*
9. Wing markings represented only by an apical band; no pterostigmal band present ..... *apicata*
Both apical band and pterostigmal band present 10
10. Wing markings indistinct; median process of third abdominal tergite extraordinarily long, measuring up to 4.2 mm., divided into two portions; hypovalvae with an abruptly narrowed apex (figs. 155, 164) ..... *choui*
Wing markings distinct; median process of third abdominal tergite not very long; hypovalvae without abruptly narrow apex 11
11. Wing markings less developed, with a long narrow band and a suspicion of dark on the wing apex; wings with dark longitudinal stripes among their veins and their branches; 7th abdominal segment of male with truncated apex (fig. 188) ..... *brisi*
Wing markings well developed, with broad pterostigmal and apical bands; no longitudinal stripes occur among veins and their branches 12
12. Pterostigmal band with broad basal branch and a separate, narrow apical branch; genital bulb as in figure 162 ..... *heii*
Pterostigmal band with both basal and apical branches, apical branch not separated from the pterostigmal band itself 13
13. Apical band interrupted posteriorly, without hyaline spots 14
Apical band not interrupted posteriorly, with hyaline spots 15
14. Fore wing length measures 14 mm.; median process of the third abdominal segment short, with rounded posterior margin, about half the length of the fourth tergite; genital bulb as in figure 194.. *chelata*
Fore wing length measures 16 mm.; median process of the third abdominal segment narrow and long, almost as long as the fourth tergite ..... *cavaleriei*

15. No additional band occurs between pterostigmal band and apical band 16
A narrow band occurs between pterostigmal and apical band 18
16. Basal band interrupted, represented by two spots which are separated from the marginal spot ..... *lacunaris*
Basal band not interrupted, but irregular, connected with the marginal spot 17
17. Wing markings brown; harpagones with large square-shaped basal lobes; apex of hypovalvae rounded (fig. 148) ..... *translucida* n. sp.
Wing markings sooty brown; harpagones without true lobes; apex of hypovalvae more or less pointed in ventral view (fig. 151) ..... *pielina*
18. Outer margins of hypandrium and hypovalvae slightly concave at the middle; parameres present, consisting of a narrow stalk, which gives rise to two branches (fig. 141) ..... *mutabilis* n. sp.
Outer margins of hypandrium and hypovalvae abruptly concave at the middle; parameres absent 19
19. Hypovalvae slender, with rounded apex as in figure 143 ..... *maai* n. sp.
Hypovalvae broad and stout, with tooth-like apex in ventral view as in figure 149 ..... *ovata* n. sp.

Key to the Females of Neopanorpa

The females of the following species are unknown: *cavaleriei* Navas, *lacunaris* Navas, *brisi* (Navas) Carpenter, *pilosa* Carpenter, *validipennis* Cheng, *taoi* Cheng, *ovata* n. sp.

1. Wing membrane deep yellow 2
Wing membrane slightly yellow or hyaline 4
2. Internal skeleton large, with long and stout axis which extends beyond the plate nearly one-third its length (fig. 204) ..... *caveata* n. sp.
Internal skeleton small, axis absent 3
3. Pterostigmal band with narrow apical branch; basal band interrupted; subgenital plate with deep V-shaped distal incision; internal skeleton as in figure 171 ..... *tienmushana* n. sp.
Pterostigmal band with broad apical branch; basal band complete; subgenital plate with shallow distal incision; internal skeleton as in figure 170 ..... *huangshana* n. sp.
4. Wings without color markings 5
Wings with color markings 6
5. Internal skeleton with long axis as in figure 207 ..... *nigritis*
Internal skeleton without axis as in figure 172 ..... *claripennis*
6. Wing markings represented only by an apical band; no pterostigmal band present ..... *apicata*
Both apical band and pterostigmal band present 7
7. Wing markings indistinct 8
Wing markings distinct 9

8. Pterostigmal band of fore wing complete; subgenital plate with truncated apex; internal skeleton as in figure 202, axis long, with rounded basal ends ..... *kwangtsehi* n. sp.
Pterostigmal band of fore wing incomplete, represented only by a faint basal branch; subgenital plate with a narrow U-shaped distal incision; internal skeleton as in figure 154, axis long, with abruptly curved hook-shaped basal ends ..... *choui*
9. Pterostigmal band with same broad basal branch, but no apical branch; internal skeleton as in figure 181 ..... *banksi*
Pterostigmal band with both basal and apical branches 10
10. Either basal branch or apical branch of pterostigmal band interrupted 11
Both basal branch and apical branch of pterostigmal band complete 14
11. Apical branch of pterostigmal band interrupted, very narrow; basal branch complete 12
Apical branch of pterostigmal band complete; basal branch interrupted 13
12. Wing markings slightly gray; between the pterostigmal band and apical band there is an additional band; internal skeleton as in figure 200, axis straight ..... *maai* n. sp.
Wing markings sooty brown, no additional band between pterostigmal band and apical band; internal skeleton as in figure 212, axis fork-shaped ..... *heii*
13. Apical band interrupted posteriorly; internal skeleton as in figure 214 ..... *varia*
Apical band not interrupted posteriorly, with a faint hyaline spot ..... *dimidiata*
14. Apical band large, complete, without hyaline spot 15
Apical band more or less interrupted or with prominent hyaline spot.. 16
15. Basal spot present; internal skeleton U-shaped as in figure 179 ..... *cantonensis* n. sp.
Basal spot absent; internal skeleton with widely divergent arms as in figure 183 ..... *pulchra*
16. Internal skeleton with long and paired axis 17
Internal skeleton without axis or with single, short axis 19
17. Wing markings brown; subgenital plate with deep V-shaped distal incision; internal skeleton as in figure 201; the length of axis is nearly the same length as the posterior arms ..... *translucida* n. sp.
Wing markings sooty brown; distal incision of the subgenital plate not deep V-shaped; the axis of the internal skeleton longer than the posterior arms 18
18. Wing membrane slightly yellow; rostrum shining reddish brown; subgenital plate with shallow V-shaped distal incision; internal skeleton

as in figure 206 ..... *pielina*

Wing membrane hyaline; rostrum deeply grayish brown; subgenital plate narrow distally, with small U-shaped distal incision; internal skeleton as in figure 205 ..... *mutabilis* n. sp.

19. Wing markings brown; internal skeleton V-shaped as in figure 178 .... *chaoi* n. sp.

Wing markings sooty brown; internal skeleton more or less U-shaped..20

20. Internal skeleton with very short median axis as in figure 185 .... *parva*

Internal skeleton without true axis 21

21. Subgenital plate abruptly narrowed posteriorly, with wide U-shaped distal incision; internal skeleton with a long stalk at its base as in figure 203 ..... *latipennis*

Subgenital plate gradually narrowed posteriorly, with shallow V-shaped distal incision; internal skeleton without long stalk at its base 22

22. Wing length measures up to 16 mm.; wing membrane slightly yellow; apical band with one hyaline spot posteriorly; outer margins of the internal skeleton smooth as in figure 180 ..... *carpenteri* n. sp.

Wing length measures only 14 mm.; wing membrane hyaline; apical band interrupted posteriorly, without hyaline spot; outer margins of the internal skeleton sinuous as in figure 173 ..... *chelata*

Descriptions of Species of Neopanorpa

Neopanorpa caveata n. sp.

Figures 128, 129, 133, 137, 204, 208, 290

Body light brown; vertex brown with a blackish brown mark enclosing ocelli; rostrum uniformly reddish brown; thorax yellowish brown laterally with six black spots, the middle of the meso- and metanotum blackish brown; in addition to mesonotum, there is usually a blackish brown streak along its anterior side margins; the 1st to 5th abdominal segments of male blackish brown dorsally; 6th abdominal segment blackish brown with reddish brown hind margin; last few segments reddish brown, median process of the 3rd tergite short, never extending beyond the hind margin of the 4th tergite and in contact with the conical production on the median axis of the latter; the 1st to 5th abdominal segments of female blackish brown dorsally, last few segments slightly reddish brown. Fore wing: length, 15-16 mm.; width, 3.5 mm. (holotype, length, 15 mm.; width, 3.5 mm.); membrane yellow, markings deep brown; pterostigmal band complete with broad basal branch and apical branch; basal band complete;

apical band large, usually joined to the pterostigmal band by some very narrow additional network-like bands so as to form several hyaline spots; basal spot absent; marginal spot large, band like; pterostigma not very prominent. Hind wing: length, 13-14 mm.; width, 3.4 mm.; similar to fore wing, except that the basal band is represented only by a spot, the network-like additional bands not so developed and the marginal spot entirely lacking. Male genitalia: genital bulb slender; coxopodites long with truncated apex; harpagones slender; the outer margin slightly concave at the middle, inner margin with a slightly protruded median portion and a small true basal lobe; hypandrium very long; hypovalvae stout, the outer margin smoothly curved towards its apex, the inner margin rather straight, the basal parts widely separated and the distal parts slightly separated from each other, the apex of hypovalvae usually reaching to the middle of the harpagones; parameres very short, basal portions bending inward and then upward, the whole paramere fused with the basal part of aedeagus; preëpiproct abruptly narrowed at the distal portion with truncated apex; aedeagus very small, the apical processes united together, lateral processes tooth-like, usually bending upward, the base of aedeagus provided with a pair of sclerotized elongate plates. Female genitalia: subgenital plate rather broad with V-shaped distal incision; internal skeleton large, the plate mostly occupied by the axis with U-shaped posterior arms, which are somewhat twisted, the axis very large and stout, extending beyond the plate nearly one-third its length.

Holotype (♂): Ta-chu-lan, Shaowu Hsien, Fukien, June 13, 1945 (Maa); in Museum of National Foochow University, Foochow. Allotype (♀): same locality as holotype; June 10, 1944 (Maa); in Museum of National Foochow University, Foochow. Paratypes: 1♂, 10♀♀, same locality as holotype, June 3-10, 1943-1945; 1♀, same locality, Aug. 13, 1943; 1♀, same locality, Sept. 29, 1943; 1♀, Tung-mu-kwan, Chungan Hsien, Fukien, May 17, 1945; 1♀, San-chiang, Chungan Hsien, Fukien, Aug. 12, 1945 (Lin); 3♀♀, Chien-men; Kwantseh Hsien, Fukien, 4♂♂, 74♀♀, Ta-chu-lan, Shaowu Hsien Fukien, April 28-Sept. 20, 1942-1945 (Maa) in Maa Collection; 1♂, 1♀, Sien-feng-ling, Chingan Hsien, Fukien, June 3-10, 1943, in Museum of Comparative Zoology; 1♂, 3♀♀, Ta-chu-lan, Shoawu Hsien,

Fukien, May 8-June 13, 1942-1943 (Maa), in Cheng Collection, Taipeh.

The color of the wing membrane of this species resembles that of *Neopanorpa ophthalmica* Navas and *sauteri* Esben-Petersen, but the markings are quite different. In *ophthalmica* and *sauteri*, the apical band is completely separated from the pterostigmal band and without rounded hyaline spots, whereas that of *caveata* n. sp. is usually connected with the pterostigmal band by some network-like bands and forms several rounded hyaline spots. The shape of the hypovalvae of the male and the very large axis of the female also make its recognition easy.

Neopanorpa tienmushana n. sp.

Figures 130, 134, 138, 167, 171, 292

Body mostly brown; vertex brown, with a narrow longitudinal median band posteriorly and a blackish brown mark enclosing ocelli; rostrum yellowish brown, with a black median longitudinal stripe on its distal half; thorax light brown; meso- and metanotum with a black median longitudinal streak; the 1st to 5th abdominal segments of male black dorsally, last few segments reddish brown, median process of 3rd tergite short, extending a little beyond the middle of the 4th tergite; the 1st to 9th abdominal segments of female uniformly blackish brown. Fore wing: length, ♂, 13-14 mm., ♀, 13-14 mm.; width, ♂ ♀, 3.4-3.5 mm. (holotype, length, 13 mm.; width 3.4 mm.); membrane yellow; markings deep brown; pterostigmal band complete, with a broad basal branch and narrow apical branch; basal band complete, narrow; apical band large, with a large prominent hyaline spot and sometimes also with a faint spot; basal spot small, marginal spot long, narrow, connected with the basal band; pterostigma not very prominent. Hind wing: length, ♂, 11.7-12.5 mm., ♀, 11.4-12.5 mm.; width, ♂, 3-3.5 mm., ♀, 3-3.2 mm.; similar to fore wing, except that the basal band is indicated only by a spot at the hind margin and both basal and marginal spots are entirely lacking. Male genitalia: genital bulb slender; the outer margin slightly concave at the middle, inner margin with a slightly projecting median portion and a small true basal lobe; hypandrium very long; hypovalvae stout, wide apart at base, their apical parts overlapping each other, the outer margins

concave at the middle, the inner margins straight, each with a proximal lobe, reaching to the middle of the harpagones; parameres very small, Y-shaped, the outer branches simple, connected with the lateral processes of the aedeagus, inner branches longer, with twisted narrow apices; preëpiproct narrowed towards apex, with a small U-shaped distal incision; aedeagus with the two apical processes united together, lateral processes extending upward, with tooth-like apex. Female genitalia: subgenital plate broad, with a wide V-shaped distal incision; internal skeleton small, U-shaped, the posterior arms rather sharp distally, broad basally, with a sclerotized bridge; no axis present.

Holotype (♂): Tien-mu-shan, Chekiang, June 6, 1936; in Museum of Institute of Zoology, Academia Sinica, Shanghai. Allotype (♀): Same collecting data and same type location as holotype. Paratypes: 3♂♂, 3♀♀, same locality as holotype, June 12, 1936, in Museum of Institute of Zoology, Academia Sinica, Shanghai; 1♂, 1♀, same locality as holotype, Aug. 15-19, 1936, in Museum of Comparative Zoology; 3♂♂, 2♀♀, same locality, June 6, 1936, 1♂, 3♀♀, same locality, July 9-26, 1936, in Cheng Collection, Taipeh.

This species, having deep yellow wing membranes, resembles the Formosan species, *Neopanorpa ophthalmica* Navas, in wing markings, but differs in the shape of the male genitalia. The length of the hypovalvae of *ophthalmica* is the same length as its hypandrium (Esben-Petersen, 1921), whereas that of *tienmushana* is much shorter than its hypandrium. The preëpiproct of *ophthalmica* is not narrowed toward the apex, and has only a slightly concave hind margin, whereas that of *tienmushana* is narrowed towards the apex, with a small U-shaped distal incision.

Neopanorpa huangshana n. sp.

Figures 135, 139, 166, 170, 291

Body reddish brown; vertex blackish brown anteriorly, with a black mark enclosing ocelli; rostrum reddish brown, with a deep brown longitudinal stripe on each side; thorax reddish brown, meso- and metanotum with black median longitudinal streak; the 1st to 5th abdominal segments of male black dorsally,

6th segment uniformly blackish brown, last few abdominal segments reddish brown, median process of 3rd tergite short, not extending beyond the middle of the 4th tergite; the 1st to 9th abdominal segments of female uniformly blackish brown. Fore wing: length, ♂, 12.5 mm., ♀, 13.2-14 mm.; width, ♂, 3 mm.; ♀, 3.5 mm. (holotype, length, 12.8 mm.; width, 3.2 mm.); membrane yellow, markings deep brown; pterostigmal band complete, with broad basal branch and apical branch; basal band complete, broader than that of *tienmushana;* apical band large, with small hyaline spot at the hind margin; basal spot small; marginal spot elongated, connected with the basal band; pterostigma not very prominent. Hind wing: length, ♂, 11 mm., ♀, 12-13 mm.; width, ♂, 3 mm., ♀, 3.3 mm.; similar to fore wing, except that the basal band is indicated only by a spot at the hind margin and both basal and marginal spots are entirely lacking. Male genitalia: similar to those of *tienmushana*, except that the outer margin of the hypovalvae are not concave, the inner margin is without the proximal lobe, the apex of the preëpiproct is rather truncated, without the small U-shaped distal incision, and the two apical processes of the aedeagus are slightly separated. Female genitalia: similar to those of *tienmushana*, except that the V-shaped distal incision of the subgenital plate is wider and the two bases of the posterior arms are smaller and are separated from each other more than those of *tienmushana*.

Holotype (♂): Huang-shan, Anhwei, June 19, 1936; in the Museum of Institute of Zoology, Academia Sinica, Shanghai. Allotype (♀): same locality as holotype; Aug. 5 ,1936; in same type location as holotypes. Paratypes: 1♀, same locality as holotype, June 21, 1936; in Cheng Collection, Taipeh.

This species resembles *Neopanorpa tienmushana* n. sp. superficially, but differs in the shape of the hypovalvae and especially in the absence of the small U-shaped incision at the distal end of the preëpiproct. This species also differs from *Neopanorpa ophthalmica* Navas by the short hypovalvae of the male and the more extensive wing markings.

Neopanorna claripennis Carpenter

Figures 131, 132, 136, 140, 168, 172

Neopanorpa claripennis Carpenter, 1938, Proc. Ent. Soc. Washington, **40**(9):273, figs. 21 24.

Body mostly black; vertex black; rostrum uniformly light brown; median process of third abdominal tergite of male very short. Fore wing: length, 13 mm.; width, 3 mm.; wing membrane hyaline, slightly smoky, without color markings, although a few of the specimens have a very slight indication of gray distally; pterostigma large, dark gray, prominent. Hind wing: similar to the fore. Male genitalia: genital bulb elongate; coxopodites rather long; harpagones slender, with a prominent lobe on the inner margin proximally; hypandrium conspicuous; hypovalvae well-developed, reaching to the base of the harpagones, flattened apically and much broader distally than proximally. Parameres very small, filamentous; preëpiproct with nearly truncated apex; aedeagus with short apical processes, united with each other, lateral processes tooth-shaped, extending posteriorly. Female genitalia: subgenital plate broad, with small V-shaped incision posteriorly; internal skeleton small, U-shaped, the axis apparently entirely absent.

Holotype (♂): Beh-luh-din (6000 ft., 30 miles north of Chengtu) Szechwan, July 28, 1923 (D. C. Graham); in U. S. National Museum. Allotype (♀): Chengtu, Szechwan, 1936 (D. C. Graham); in U. S. National Museum.

Distribution: Beh-luh-din, Szechwan, July 23-Aug. 28, 1923 and 1933; Chengtu, Szechwan, 1936.

This species, without color markings, resembles *Neopanorpa apicata* Navas. However, according to Carpenter's idea, the tip of the wing of *apicata* shows a prominent darkening of the apex (hence the name *apicata*), whereas that of *claripennis* lacks the darkened apex. Also, in Navas' drawing, the wing of *apicata* gives no indication of a prominent pterostigma, whereas that of *claripennis* is made very prominent by its color. Unfortunately, according to Navas, the type of *apicata* (♂) lacks the terminal portion of the abdomen, so we shall never know the genital structure of the type.

Neopanorpa taoi Cheng

Figures 157, 158, 159, 160

Neopanorpa taoi Cheng, 1949, Psyche, **56**(4):155, figs. 10, 58, 66, 68.

Body light brown; vertex entirely black; rostrum light brown, with sooty brown stripe on each side; pronotum sooty brown, meso- and metanotum sooty brown on the median portion; the 1st to 5th abdominal segments of male sooty brown dorsally, last few abdominal segments brown in color, median process of third abdominal tergite short, with swollen and truncated apex, not extending beyond the middle of the fourth tergite. Under this process, there is a small median process and a pair of lateral processes; the fourth tergite is provided with a concave area on its anterior portion. Fore wing: length, 17 mm.; width, 3.8 mm.; membrane hyaline with slightly grayish tinge, no markings present; R_{2a} forked into R_{2a1} and R_{2a2}; pterostigma prominent. Hind wing: length, 15.8 mm.; width, 3.8 mm.; similar to the fore. Male genitalia: genital bulb slender; coxopodites long, narrow distally, bearing many long hairs; harpagones rather short, the outer margin convex near the base, furnished with a series of short barbs at the middle, inner margin with a large basal lobe which bears two tooth-like processes; hypandrium broad, hypovalvae wide apart basally, slightly overlapping each other distally, the basal outer margins greatly convex and strongly sclerotized; parameres simple, leaf-shaped; preëpiproct slender, with median concave margins, the distal outer portions extended laterally forming large, distal, tooth-like processes; aedeagus rather small, both apical processes and lateral processes tooth-like, extending the same direction and having nearly the same size.

Female unknown.

Holotype (♂): Mt. Lo, Sichang, Sikang, June 10, 1944 (Chia Chu Tao); in Cheng Collection, Taipeh.

This species, without any wing markings, differs from the other described *Neopanorpa* by the broadened apex of its median process of the third abdominal tergite and also by the structure of its male genitalia, especially the double-toothed basal lobes of the harpagones and the simple parameres.

Neopanorpa pilosa Carpenter

Figures 192, 193

Neopanorpa pilosa Carpenter, 1945, Psyche, **52**(1-2):75, text-figs. 1, 2.

Body light brown, the vertex, thoracic nota and first four abdominal tergites blackish brown; male with the median process of the third abdominal tergite well developed, reaching almost to the hind border of the fourth segment. Fore wing: length, 17.5 mm.; width, 3.8 mm., membrane nearly hyaline, faintly smoky in appearance; no markings: pterostigma pale yellow. Male genitalia: genital bulb slender, coxopodites very long; harpagones rather short, the outer margin concave near the base and with a large cluster of short black hairs near the middle; each of the harpagones has a prominent lobe on the inner margin near the base, bearing a number of long black hairs; similar hairs arise from a short papilla on the distal inner margin of coxopodites; hypandrium conspicuous; hypovalvae broad and long, reaching well beyond the base of the harpagones; each is folded along the outer margin; parameres small, branched; preëpiproct with a pair of thick, distal processes, enlarged distally and directed inward towards the interior of the bulb; both apical processes and lateral processes of the aedeagus tooth-like, extending in the same direction and having nearly the same size.

Female unknown.

Holotype (♂): Suifu (1000 ft.), Szechwan, Aug., 1928 (D. C. Graham); in U. S. National Museum.

Distribution: same as type.

This species, without any wing markings, resembles *Neopanorpa taoi* Cheng superficially, but differs in the structure of the male genitalia, especially the parameres. In *taoi*, the parameres are simple, leaf-like, whereas those of *pilosa* are branched. This species also bears some resemblance to *nigritis* Carpenter, but is much larger and has a lighter body. In *nigritis*, the outer margins of the harpagones of the male are normal and smooth, whereas those of *pilosa* are distinctly convex at their base.

Neopanorpa nigritis Carpenter

Figures 189, 190, 191, 207, 211, 219, 287

Neopanorpa nigritis Carpenter, 1938, Proc. Ent. Soc. Washington **40**(9): 274, figs. 17-20.

Body mostly black; vertex black; rostrum light brown, but with a wide, median black stripe along the anterior surface; the entire abdomen of male including genital bulb, black, though the tips of the genital harpagones are reddish brown; median process of third abdominal tergite well-developed, reaching almost to the hind border of the fourth segment; the entire abdomen of female like the male, black. Fore wing: length, 13 mm.; width, 3 mm.; wing membrane nearly hyaline, faintly smoky in appearance; no markings present; pterostigma well-developed, reddish brown. Hind wing: length, 12 mm.; width, 3 mm.; similar to the fore. Male genitalia: genital bulb slender, coxopodites long; harpagones only of moderate length, with a small lobe proximally on the inner margin; hypandrium not very conspicuous; hypovalvae slender, not quite reaching to the base of the harpagones, nearly membranous distally, their tips bent slightly; parameres simple, each consisting of a slender stalk, broader distally than proximally; preëpiproct slender, with abruptly broader distal portion, the apex slightly emarginate, the distal outer portion extended laterad to embrace the proctiger as shown in figure 190; aedeagus with short apical processes and tooth-like lateral processes. Female genitalia: subgenital plate broad, with a V-shaped distal incision; internal skeleton with the axis projecting beyond the plate, the two posterior arms being well-developed and reaching to the tips of the subgenital plate.

Holotype (♂): Mt. Omei (1000 ft.) Szechwan, July 19, 1936 (D. C. Graham); in U. S. National Museum. Allotype (♀): same collecting data and type location as holotype.

Distribution: Mt. Omei (7000-9000 ft.), Szechwan, July 19, 1936.

This species, without any wing markings, differs from the other described similar *Neopanorpa* by its short and slender hypandrium and hypovalvae. The wings of this species resemble those of *N. claripennis* Carpenter, but the body color, the median stripe on the rostrum, the long median process of the third abdominal tergite of the male and the large internal skeleton of the female make its recognition easy.

Neopanorpa validipennis Cheng

Figures 145, 146, 217, 222, 227, 288

Neopanorpa validipennis Cheng, 1949, Psyche, **56**(4):154, figs. 46, 47, 48, 64, 65.

Vertex entirely black; rostrum deep brown, with a median longitudinal light brown streak; thorax sooty brown dorsally, brown laterally, the 1st to 5th abdominal segments of male dark brown dorsally, reddish brown ventrally, 6th segment long, sooty brown, 7th segment reddish brown, 8th segment reddish brown anteriorly, sooty brown posteriorly; both the 7th and 8th segments broaden towards apex, the posterior end of the pleural regions of the 7th segment protruded posteriorly to form two small processes; median process of the third tergite rather long, extending nearly to the hind border of the 4th tergite, pointed at the apex when seen dorsally. Under this median process, there is another small reddish process, and on both sides of this median process is a pair of small tooth-like prolongations; the median axis of the 4th tergite slightly protruding upward. Fore wing: length, 14.5 mm.; width, 3.5 mm.; membrane slightly grayish brown, no markings present; veins very stout, R_{2a} usually forked into R_{2a1} and R_{2a2}; pterostigma not very prominent. Hind wing: length, 13.5 mm.; width, 3.5 mm.; similar to fore wing. Male genitalia: genital bulb slender; coxopodites very long, abruptly narrow distally, bearing a number of long hairs on the distal inner margins; harpagones short and slender, the outer margin slightly concave at the middle, furnished with a series of short barbs at the basal half, inner margin with a large lobe basally; hypandrium long, slightly narrowed towards apex; hypovalvae with slender basal stalks, wide apart basally, overlapping each other, the outer borders extending laterad and being concave near its middle; parameres club-shaped with rounded apex; preëpiproct slender with rounded apex, the distal outer portion extended laterad to embrace the proctiger, and forming distal tooth-like processes; aedeagus very small, the two apical processes nearly united, lateral processes extended posteriorly, sharp and tooth-like.

Female unknown.

Holotype (♂): Jihti (30 miles east of Tachienlu), Sikang,

Sept. 2, 1939 (F. Y. Cheng, Io Chou and Tein Ho Hei); in Cheng Collection, Taipeh.

Distribution: same as type.

This species, without any wing markings, differs from the other described *Neopanorpa* by the rounded basal lobes of the harpagones and the very long hypandrium and hypovalvae, which extend far beyond the base of the harpagones. The very stout veins of this species also make its recognition easy.

Neopanorpa apicata Navas

Neopanorpa apicata Navas, 1927, Rev. Acad. Ciene. Zaragosa, 7:27, fig. 6.

Head deep black; rostrum yellow; thorax entirely black; abdominal segments mostly black with yellow hairs; the terminal portion of the abdomen is lacking in the ♂ type. However, the last segment of the remaining abdomen is yellow. Fore wing: membrane hyaline, iridescent, no marking present, except a dark shadow at the wing apex; the inner margin of this shadow is straight, and the shadow disappears gradually posteriorly; between the veins there are longitudinal indistinct lines formed by the presence of the black hairs; veins black; pterostigma not prominent. Hind wing: similar to the fore wing. Both ♂ and ♀ genitalia are not known.

Type (♀): Kweichow (Cavalerie); originally in Navas Collection.

Distribution: same as type.

This species, having reduced wing markings, differs from other described *Neopanorpa* by the presence of the apical band and the absence of the other markings. I have not seen this species. The above account is based upon Navas' original description.

Neopanorpa choui Cheng

Figures 153, 154, 155, 161, 164, 165

Neopanorpa choui Cheng, 1949, Psyche, **56**(4):151, figs. 22, 23, 43, 44, 45, 62.

Body light brown, the middle part of the thoracic nota sooty brown; vertex entirely black; rostrum yellowish brown; median process of the third abdominal tergite of male extraordinarily long (measuring up to 4.2 mm.), apparently divided into two

portions and bearing a series of dense, short stiff hairs on its ventral surface; the fourth tergite extremely long, covering several of the following abdominal segments, somewhat elevated, and furnished with many short stiff hairs on its surface. Fore wing: length, 3.5 mm.; width, 3 mm.; membrane smoky hyaline, markings slightly brown, very indistinct; pterostigmal band incomplete, usually represented only by the faint basal branch and apical branch; basal band represented only by two small spots on the hind margin; apical band large; pterostigma brown, very prominent. Hind wing: length, 12 mm.; width, 3 mm.; similar to fore wing, except that the pterostigmal band and the basal band are entirely lacking. Male genitalia: genital bulb slender; coxopodites long, with truncated apex; harpagones slender, the outer margin concave at the middle, inner margin with a triangular angle and a large basal lobe; hypandrium short and broad; hypovalvae broad and less sclerotized, with an abruptly narrow apex, extending beyond the base of the harpagones; parameres modified into a pair of sclerotized rods, greatly swollen distally and with an incised apex and fused with the basal part of aedeagus basally; preëpiproct narrow distally, with truncated and slightly concave apex; aedeagus rather small, the two apical processes united together; lateral processes extending upward with tooth-like apex. Female genitalia: subgenital plate broad basally, narrowed towards apex, with a narrow U-shaped incision distally; internal skeleton large, the plate small, less sclerotized, its posterior arms narrow and slender, sword-shaped, the axis very stout, with abruptly curved hook-shaped basal ends.

Holotype (♂): Mt. Chowkung, Yaan, Sikang, July 14, 1939 (F. Y. Cheng, Io Chou and Tein Ho Hei); in Cheng Collection, Taipeh. Allotype (♀): same collecting data and type location as holotype.

Distribution: same as types.

This species, having very indistinct wing markings, differs from other described *Neopanorpa* by its very long median process of the third abdominal segment and the peculiar structures of both the male and the female genitalia.

Neopanorpa brisi (Navas)

Figure 188

Neopanorpa (?) *brisi* (Navas), Carpenter, 1938, Proc. Ent. Soc. Washington, **40**(9):280.

Leptopanorpa brisi Navas, 1930, Notes d'Ent. Chin. Mus. Heude, **1**(6):4. fig. 3.

Vertex yellowish brown anteriorly, black posteriorly; rostrum slender, brownish yellow with an inverted T-shaped mark at its base; thorax black dorsally, yellowish brown ventrally and laterally; 1st and 2nd abdominal segments black dorsally; median process of 3rd tergite with parallel margins and extending to the hind border of the 4th tergite, bearing a short golden fringe, 4th and 5th segments also black dorsally with a yellowish brown posterior margin, 6th segment partly cylindrical and partly conical, brownish yellow dorsally, with indistinct dark lines running lengthwise, 7th segment narrow, rather short and subcylindrical, narrow basally, obliquely truncated at the distal end; the upper lateral corner is bidentate; seen from above it is dilated posteriorly and cut off in a bow. Fore wing: length, 17 mm.; apex rounded, elliptical; membrane light grayish yellow, markings brownish yellow; only one long and narrow marking on the wing, the apex is somewhat darkened; veins black; among the veins and their branches there are dark longitudinal stripes. Hind wing: length, 15.5 mm.; similar to the fore, except that the longitudinal stripes are not so distinct as those of the fore wing. Male genitalia have not been worked out.

Female unknown.

Type (♂): Yunnan; in Navas Collection.

Distribution: same as type.

This species, having reduced wing markings, differs from other described *Neopanorpa* by the dark longitudinal stripes among their veins. The truncated apex of the 7th abdominal segment of the male also makes its recognition easy. I have not seen this species. The above account is based upon Navas' original description.

Neopanorpa kwangtsehi n. sp.

Figures 198, 202, 289

Vertex entirely black; rostrum grayish brown, with a pale white median longitudinal stripe; thorax yellowish brown, with a wide sooty brown median longitudinal band dorsally; abdominal segments of female sooty brown dorsally, yellowish brown laterally and ventrally. Fore wing: length, 13.5 mm.; width, 3.15 mm.; membrane slightly brown, markings light grayish brown, indistinct; pterostigmal band complete, with complete basal branch and apical branch; basal band interrupted, not prominent; apical band large, with three windows; basal spot absent; marginal spot very small; pterostigma prominent, deep brown. Hind wing: length, 12.2 mm.; width, 3 mm.; no markings present, except for a slight suspicion of grayish brown at the apex of wing and deep brown at the pterostigma. Female genitalia: subgenital plate broad, with truncated apex; internal skeleton large, the plate with concave anterior margin, posterior arms of the plate U-shaped, axis prominent, but not extending beyond the plate.

Male unknown.

Holotype (♀): Chinmen, Kwangtseh, Fukien, Aug. 22, 1945 (Maa); in Maa Collection.

This species, having indistinct wing markings, differs from the other described *Neopanorpa* by the truncated apex of the subgenital plate and the shape of the internal skeleton.

Neopanorpa hei Cheng

Figures 156, 162, 163, 212, 213, 293

Neopanorpa hei Cheng, 1949, Psyche, **56**(4):152, figs. 35, 36, 49, 50, 51.

Vertex entirely black; rostrum uniformly brown; thorax sooty brown dorsally, deep brown laterally; the 1st to 5th abdominal segments of male sooty brown dorsally, deep brown laterally and ventrally, 6th abdominal segment twice the length of 5th segment, sooty brown in color, last three abdominal segments also very long, deep brown in color; median process of the third tergite short, never extending to the middle of the fourth tergite, and in contact with the conical projection on the median axis of

the fourth tergite; abdominal segments of female sooty brown dorsally, deep brown laterally and ventrally. Fore wing: length, ♂, 12.8 mm.; ♀, 13.5 mm.; width, ♂, 3.2 mm.; ♀, 3 mm.; membrane slightly brown, markings sooty brown; pterostigmal band complete, with a broad basal branch and a greatly reduced and separated apical branch; basal band represented by a reduced marking on the hind margin; apical band well developed; basal spot very small; marginal spot consisting of two reduced spots; pterostigma prominent. Hind wing: length, ♂, 11.5 mm.; ♀, 12.2 mm.; width, ♂, 3.2 mm.; ♀, 3 mm.; similar to fore wing, except that apical branch of pterostigmal band, basal band, basal spot and marginal spot are entirely lacking. Male genitalia: genital bulb slender; coxopodites rather long, with a protruding apex; harpagones very slender, the outer margin slightly concave at the middle, inner margin with a smooth angle and a true basal lobe; hypandrium rather long; hypovalvae not flattened, broadend towards the apex, the basal portion wide apart, the median inner parts greatly prolonged upward and overlapping each other; parameres apparently absent; preëpiproct slightly narrowed towards the apex, the distal portion bent laterad and caudad so as to embrace the proctiger; aedeagus very small, both the apical and the lateral processes tooth-like, the basal part usually covered by a pair of elliptical membranous plates. Female genitalia; subgenital plate broad, with a wide U-shaped distal incision; internal skeleton small, the plate being band-shaped, transversely elongated, the posterior arms of the internal skeleton lanceolate, extending laterad and reaching to the side margins of the subgenital plate; the axis small, fork-shaped, the distal portion of the forks joined closely with the basal posterior arms.

Holotype (♂): Mt. Chowkung, Yaan, Sikang, July 29, 1939 (F. Y. Cheng, Io Chou and Tein Ho Hei); in Cheng Collection, Taipeh. Allotype (♀): same collecting data and deposition as holotype.

Distribution: same as types:

This species superficially resembles *Neopanorpa cavaleriei* Navas in the wing markings, but it can be distinguished by the smaller wing size, the greatly reduced apical branch of the pterostigmal band in the fore wing and the entire lack of this

band in the hind wing. Another difference is the unforked R_{2a} of this species as compared with the forked R_{2a} in the redescribed figure of *cavaleriei* by Esben-Petersen (1921, fig. 93). This species also resembles *N. chelata* Carpenter, in wing markings, but these two species are at once distinguished by the forms of both the male and the female genitalia.

Neopanorpa chelata Carpenter

Figures 169, 173, 186, 194, 195, 216, 299

Neopanorpa chelata Carpenter, 1938, Proc. Ent. Soc. Washington, **40**(9): 274, figs. 13-16.

Body brown and black; vertex black; rostrum light brown; thorax mostly brown, with a wide median dorsal black stripe; abdomen black above, the segments beyond the fifth reddish brown, median process of the third abdominal tergite prominent, with rounded posterior margin. Fore wing: length, 14 mm.; width, 3 mm.; membrane hyaline, markings sooty brown, apical ban dpresnt, but usually interrupted posteriorly; pterostigmal band entire, with broad basal branch and very narrow apical branch; basal band interrupted, represented as three spots; basal spot absent; marginal spot present; pterostigma rather prominent. Hind wing: length, 13 mm.; width, 3 mm.; similar to fore wing. Male genitalia: genital bulb slender; coxopodites rather long; harpagones unusually long and slender, with a prominent proximal lobe on the inner margin; hypandrium conspicuous; hypovalvae broad, especially distally, each possessing an outer small apical lobe, reaching to the base of the harpagones; parameres greatly reduced, mostly united with aedeagus; preëpiproct slender, with round distal margin; apical processes of aedeagus short, united with each other, lateral processes short, tooth-like. Female genitalia: subgenital plate broad, abruptly narrowed posteriorly, with a narrow V-shaped distal incision; internal skeleton small, posterior arms U-shaped, axis apparently absent.

Holotype (♂): Shinkaisi, Mt. Omei, Szechwan, Aug. 16-20, 1934; in U. S. National Museum. Allotype (♀): same collecting data and type location as holotype.

Distribution: same as holotype; Chengtu, Szechwan, 1936;

foot of Mt. Wa (6000-7000 ft.), Szechwan, July 27, 1925; Kuanshien, Szechwan, 1936.

This species resembles *Neopanorpa cavaleriei* Navas. However, the median process of the third abdominal tergite of *cavaleriei* is narrow and long, almost reaching to the fifth segment, whereas that of *chelata* is short and broad. Moreover, the wing size of *cavaleriei* is larger than that of *chelata*.

Neopanorpa cavaleriei Navas

Neopanorpa cavaleriei Navas, 1908, Mem. Real. Acad. Ciene. Barc., 1908:417. Esben-Petersen, 1921, Coll. Zool. Selys Long., **5**(2):83, figs. 93, 94. Navas, 1926, Mem. Pont. Accad. Nuovi Lincei, **9**:920. *Id.*, 1930, Rev. Brot., **24**(1):13. Carpenter, 1945, Psyche, **50**(1-2):74, text-figs. 4, 7.

Head castaneous; rostrum reddish brown; thorax reddish brown dorsally, sides yellowish brown with some small linear black spots; abdomen reddish brown, the hind border of third tergite narrow and long, almost as long as the fourth segment; 6th segment cylindrical, a little narrowed towards apex; 7th segment one-fourth shorter than 6th, a little incrassated towards apex; 8th as long as 7th, thickened towards apex, which is obliquely truncated above. Fore wing: length, 16 mm.; elliptical at tip; membrane hyaline, with a faint yellowish tinge, markings blackish brown; pterostigmal band complete, with a narrow basal branch and a narrow apical branch; basal band indicated by two small spots; apical band large, with an oblique prolongation at the middle of its inner margin, connected along the anterior margin with the pterostigmal band; basal spot absent; marginal spot very small; pterostigma not very prominent; longitudinal veins and basal crossveins reddish brown, the apical crossveins not very distinct, R_{2a} forked into R_{2a1} and R_{2a2}. Hind wing: length, 14.5 mm.; similar to the fore, except that the small spot which represented the marginal spot in the fore wing is entirely absent. Male genitalia of this species has not been worked out. However, according to Esben-Petersen, the hypovalvae are rather stout, the interior margins running close together, but forming a circular hole at their base; preëpiproct is rounded at tip with long setae.

Female unknown.

Type (♂): Kweiyang, Kweichow, 1906 (Cavalerie); in Muséum National d'Histoire Naturelle, Paris.

Distribution: same as type; Tokin, Indo-china.

This species resembles *Neopanorpa chelata* Carpenter in the wing markings, but has a larger wing size. The median process of the third abdominal tergite of this species is narrow and long, almost reaching to the fifth segment, whereas that of *chelata* is short and broad. Unfortunately, the male genitalia of the type specimen of *cavaleriei* have not been worked out.

Neopanorpa lacunaris Navas

Neopanorpa lacunaris Navas, 1930, Notes d'Ent. Mus. Heude, 1(6):3, fig. 2.

Head brownish yellow; vertex black with a deep black spot within ocelli; rostrum brownish yellow, with a black stripe along each side; thorax brownish yellow, pronotum black, the first abdominal segment brownish yellow dorsally and ventrally; 2nd to 5th segments black dorsally, brownish yellow ventrally; 6th segment conical, black, with brownish yellow apex; the latter is truncated and rounded; the 8th segment tawny yellow, with the same shape and same length as in the 7th segment, except that its posterior border is obliquely truncated; the 9th segment globular, rusty brick-color, covered with black hairs; the median process of third tergite has parallel sides and extends a little beyond the tip of the fourth tergite; its apex is covered with dark hairs. Fore wing: length, 12.5 mm.; narrow, with rounded, elliptical apex, membrane hyaline, very light yellow in the basal third, markings black; pterostigmal band broad, forked posteriorly, both basal and apical branches are broad; basal band indicated by two transverse markings, one anterior and the other posterior; apical band broad, with a small hyaline spot posteriorly; basal spot absent; marginal spot present; veins black. Hind wing: length, 11.4 mm.; similar to the fore, except that the basal bands are not so distinct. Male genitalia have not been worked out.

Female unknown.

Type (♂): Yunnan; originally in Navas Collection.

Distribution: same as type.

This species differs from the other described, distinctly

marked, *Neopanorpa* by the hyaline spot bearing an apical band, the forked pterostigmal band and the interrupted basal band. I have not seen the species. The above account is based upon Navas' original description.

Neopanorpa translucida n. sp.

Figures 147, 148, 197, 201, 218, 223, 295

Body yellowish brown; vertex brown with a sooty mark enclosing ocelli; rostrum uniformly brown; thorax yellowish brown laterally with four black spots, the middle of the meso- and metanotum deep brown, the anterior portion usually deep brown in color; the 1st to 5th abdominal segments of male deep brown dorsally, 6th segment long, deep brown with somewhat restricted reddish brown apex, the 7th and 8th segments rather short and stout, reddish brown in color; median process of the 3rd tergite rather long, a little extended beyond the hind margin of the 4th tergite; the 1st to 5th abdominal segments of female deep brown dorsally, last few segments slightly reddish brown. Fore wing: length, 14.5 mm.; width, 3.7 mm.; membrane slightly yellowish brown, markings brown; pterostigmal band complete with broad basal branch and apical branch; basal band irregular; apical band very large with two hyaline spots, usually joined to the pterostigmal band by two very narrow bands; basal spot very small; marginal spot represented by an inverted Y-shaped band; pterostigma prominent. Hind wing: length, 13 mm.; width, 3.5 mm.; similar to fore wing, except that the basal band and the marginal spot are entirely lacking. Male genitalia: genital bulb slender; coxopodites long, with a bundle of 4-5 black hairs on their distal inner margins and a row of short hairs along its anterior inner margin; harpagones with broad base and slender flattened distal portion, the outer margin concave at the middle, inner margin with a small median angle and a very large square-shaped basal lobe which is concave ventrally; the inner margins of this lobe bear a dense row of black hairs, while its posterior margins bear a row of comb-like brown hairs; hypandrium rather long; hypovalvae elongated, very broad in lateral view with rounded apex, extending a little beyond the base of the harpagones; parameres very short, Y-shaped, the

inner branches free, the outer branches shorter than the inner pair, less sclerotized and fused with the basal part of aedeagus; preëpiproct somewhat restricted at its median margins and with slightly concave distal apex; aedeagus small, the apical processes united together, the lateral processes being sharp and tooth-like, extending outward and upward. Female genitalia: subgenital plate rather broad with deep V-shaped distal incision; internal skeletons rather large, the plate mostly occupied by the axis with U-shaped posterior arms which are somewhat twisted, the axis short and stout with sharp anterior end, extending only a little beyond the plate.

Holotype (♂): Ta-chu-lan, Shaowu Hsien, Fukien, May 18, 1945 (Maa); in Museum of National Foochow University, Foochow. Allotype (♀): Same locality as holotype, Aug. 7, 1945 (Maa); in Maa Collection. Paratypes: 1♂, Tao-shui, Shaowu Hsien, Fukien, June 17, 1943; 8♂♂, same locality as holotype; May 10-June 10, 1944-1945 (Maa), in Museum of National Foochow University; 1♂, Pen-tien-tung, Changting Hsien, Fukien, April 22, 1941; 1♂, Chien-men, Kwantseh Hsien, Fukien, Aug. 22, 1945; 34♂♂, 3♀♀, same locality as holotype, April 1-Aug. 20, 1942-1945 (Maa), in Maa Collection; 2♂♂, 1♀, same locality as holotype, May 8-Aug. 19, 1942-1945 (Maa), in Museum of Comparative Zoology; 5♂♂, 2♀♀, same collecting data, in Cheng collection, Taipeh.

The wing markings of this species somewhat resemble those of *Neopanorpa caveata* n. sp. However, the color of the markings and the wing membrane are much lighter than those of the latter. The shape of the harpagones and hypovalvae of the male and the short axis of the female also enable it to be easily distinguished as a distinct species.

Neopanorpa pielina Navas

Figures 151, 152, 206, 210, 301

Neopanorpa pielina Navas, 1936, Notes d'Ent. Mus. Heude, 3(4):58, figs. 72, 73.

Vertex reddish brown, with black spot between ocelli; rostrum shining reddish brown; thorax blackish brown dorsally, reddish brown laterally; the 1st to 5th abdominal segments of male

blackish brown dorsally, reddish brown ventrally, 6th abdominal segment black, with narrow reddish brown posterior border, last three abdominal segments reddish brown; median process of the third tergite long and slender, extending to the hind border of the fourth tergite, the anterior portion of the latter concave at the middle, with reddish brown color; abdominal segments of female blackish brown dorsally, reddish brown ventrally. Fore wing: length, ♂, 11.5 mm.; ♀, 12.5 mm.; width, ♂, 3 mm.; ♀, 3.2 mm.; membrane dusky hyaline, markings sooty brown; pterostigmal band complete, with broad basal branch and narrow apical branch; the anterior portion of the pterostigmal band extends outward and forms a small spot posterior to the pterostigma; basal band represented by two spots; apical band broad, with a large hyaline spot posteriorly; basal spot absent; marginal spot present; pterostigma prominent. Hind wing: length, ♂, 10.5 mm.; ♀, 11.5 mm.; width, ♂, 3 mm.; ♀, 3.2 mm.; similar to fore wing, except that the basal band is represented by only one spot. Male genitalia: genital bulb slender; coxopodites long, with truncated apex and a row of bristles on its distal inner margins; harpagones slender, the outer margins slightly concave at the middle, inner margins with a smooth median angle and a basal concave area; hypandrium conspicuous; hypovalvae broad, restricted proximally, their outer margins bent, with broader distal folded portion, extending far beyond the base of the harpagones; parameres small, Y-shaped, united with aedeagus and supported by a weakly sclerotized V-shaped bar; preëpiproct broad basally with rounded apex, its distal outer margins bearing a pair of small bent lobes; aedeagus small, the apical processes united together, lateral processes lobe-shaped. Female genitalia: subgenital plate broad at the middle, with a wide V-shaped distal incision; internal skeleton large, the outer margins of the plate less sclerotized, the posterior arms of the plate broad at the middle, abruptly narrowed apically, the axis long, enclosed by the strongly sclerotized extended posterior portion of the plate.

Types (♂ ♀): Kuling, Kiangsi, Aug. 13-16, 1935 (Piel); in Heude Museum, Shanghai.

Distribution: same as types.

This species, having complete basal and apical bands (with a hyaline spot), differs from the other described *Neopanorpa* by the peculiar structures of both the male and the female genitalia. i.e., no true lobes in the harpagones of the male and the long axis of the internal skeleton of the female. The latter usually occurs with a subgenital plate that has a wide V-shaped distal incision. The description and drawings of both the male and the female of this species are based upon the specimens labeled as paratypes in the Heude Museum, Shanghai.

Neopanorpa mutabilis n. sp.

Figures 141, 142, 205, 209, 221, 226

Body mostly blackish brown; vertex deep grayish brown with sooty brown mark enclosing ocelli; rostrum uniformly deep grayish brown; thorax deep grayish brown dorsally, meso- and metanotum with broad blackish brown streak; the 1st to 5th abdominal segments of male blackish brown dorsally, 6th segment long, blackish brown, 7th and 8th segments shorter than the 6th, reddish brown in color; median process of the 3rd tergite short, never extending beyond the hind margin of the 4th tergite; the anterior median portion of the 4th tergite less sclerotized, forming a light brown square-shaped area; the 1st to 6th abdominal segments of female blackish brown dorsally, last few abdominal segments reddish brown. Fore wing: length, ♂, 12.6 mm., ♀, 13.5 mm.; width, ♂, 3.5 mm., ♀, 3.7 mm.; membrane hyaline, markings sooty brown; pterostigmal band complete with broad basal branch and a comparatively narrow apical branch; basal band represented by two short bands which in some individuals connect with each other; apical band large with a hyaline spot posteriorly; between the apical band and the pterostigmal band there is usually a narrow additional band extending from the pterostigmal area to the hind margin of wing but in some individuals, this band is interrupted, the anterior half connected with the apical band to form a large hyaline window; basal spot absent; marginal spot elongated, band-like; pterostigma not very prominent. Hind wing: length, ♂, 11.6 mm., ♀, 12.2 mm.; width, ♂, 3.6 mm., ♀, 3.2 mm.; similar to the fore. Male genitalia: genital bulb slender; coxo-

podites long with a row of hairs on its distal inner margin; harpagones slender, the outer margin slightly concave at the middle, inner margin with a large basal concave area; hypandrium broad; hypovalvae long, broadened at their median portion, extending far beyond the base of harpagones; parameres very inconspicuous, weakly sclerotized, consisting of a narrow stalk, which gives rise to two branches, the inner branch free, the outer branch united with the lateral process of the aedeagus; preëpiproct narrowed towards its apex with slightly concave distal margin; aedeagus small, the apical processes united together, lateral processes tooth-like, extending outward and upward. Female genitalia: subgenital plate broad at the middle with narrow U-shaped distal incision; internal skeleton large, the plate mostly occupied by the long axis; posterior arms of the plate swollen at their outer margins.

Holotype (♂): Ta-chu-lan, Shaowu Hsien, Fukien, June 3, 1945 (Maa); in Museum of National Foochow University, Foochow. Allotype (♀): same locality as holotype; May 25, 1945 (Maa); in Museum of National Foochow University, Foochow. Paratypes: 11 ♀ ♀, same locality as holotype, May 10-June 10, 1945 (Maa), in Museum of National Foochow University, Foochow; 31 ♂ ♂, 64 ♀ ♀, same locality as holotype, April 23-June 13, 1942-1945; 5 ♀ ♀, Changting Hsien, Fukien, April 30-June 3, 1942-1945 (Maa and Lin), in Maa Collection; 2 ♂ ♂, 2 ♀ ♀, same collecting data as holotype, in Museum of Comparative Zoology; 2 ♂ ♂, 2 ♀ ♀, same collecting data, in Cheng Collection, Taipeh.

This species differs from previously described *Neopanorpa* by its wing markings, especially the presence of the additional band which extends from the outer part of the pterostigma to the apical band to form a large hyaline window. The structures of both the male and the female genitalia are also specific characters.

Neopanorpa ovata n. sp.

Figures 149, 150, 187, 298

Body deep brown; vertex blackish brown with black mark enclosing ocelli; rostrum deep brown; thorax blackish brown dorsally; the 1st to 5th abdominal segments of male blackish

brown, 6th segment long, slightly blackish brown, last few abdominal segments deep brown; median process of 3rd tergite rather long, reaching to the hind border of the 4th tergite, the median portion of the 4th tergite projecting to form a convex process which is situated behind the light brown square area of this tergite. Fore wing: length, 13 mm.; width, 3.4 mm.; membrane hyaline, markings brown; the wing apex rather rounded; pterostigmal band complete, with broad basal branch and narrow apical branch; basal band represented by two large spots; apical band complete, with two hyaline spots, the additional band between the apical band and the pterostigmal band as in *Neopanorpa mutabilis* n. sp.; basal spot absent; marginal spot large; pterostigma prominent. Hind wing: length, 12.2 mm.; width, 3.2 mm.; similar to fore wing, except that the basal band is represented only by a single spot. Male genitalia: genital bulb slender; coxopodites long with a row of hairs on their distal inner margins; harpagones slender, the outer margin slightly concave at the middle, inner margin slightly convex at the middle with a well developed basal concave area; hypandrium very broad; hypovalvae broad and stout, these distal outer portions usually prolonged to form a broad lobe, which is folded upward to embrace the hind part of the preëpiproct; parameres absent; preëpiproct slender, with truncated apex, rather broad a short distance behind its apex; aedeagus strongly sclerotized, with tooth-like apical and lateral processes.

Female unknown.

Holotype (♂): Pen-tien-tung, Changting Hsien, Fukien, April 22, 1941 (Maa); in Maa Collection, Taipeh.

This species is very similar to *Neopanorpa mutabilis* n. sp., but its rounded wing apex and its very broad hypovalvae enable it to be easily separated as a distinct species.

Neopanorpa maai n. sp.

Figures 143, 144, 196, 200, 220, 224, 296

Body very weak, yellowish brown; vertex grayish brown; rostrum uniformly light yellowish brown; thorax grayish brown dorsally, meso- and metanotum with deep grayish brown broad median longitudinal streak; the 1st to 5th abdominal segments of male brown dorsally, 6th segment not so prolonged as in

Neopanorpa mutabilis n. sp., brown in color, last few abdominal segments light reddish brown; median process of 3rd abdominal tergite long, extending a little beyond the hind margin of the 4th tergite, the median portion of the 4th tergite less sclerotized, forming a light brown square area, which is much smaller than that of *mutabilis;* the 1st to 9th abdominal segments of female uniformly yellowish brown. Fore wing: length, 14 mm.; width, 3.8 mm.; membrane hyaline, markings slightly gray; pterostigmal band complete with a broad basal branch and a separate apical branch; basal band complete, irregular; apical band large with a median hyaline band; between the apical band and the pterostigmal band there is an additional band, as in *mutabilis*, the middle portion of this band being usually connected with the apical branch of the pterostigmal band; basal spot absent; marginal spot elongated; pterostigma not prominent. Hind wing: length, 12.5 mm.; width, 3.5 mm.; similar to the fore. Male genitalia: genital bulb slender; coxopodites long with a row of short hairs on their distal inner margins; harpagones slender, the outer margin slightly concave at the middle, inner margin with a rounded angle and a basal concave area which is not so developed as in *mutabilis;* hypandrium broad; hypovalvae shorter than those of *mutabilis*, extending a little beyond the base of the harpagones; parameres absent; prëpiproct broad at the middle, slender distally with slightly concave distal margin; aedeagus small, the apical processes united together, lateral processes tooth-like, short. Female genitalia: subgenital plate broad at the middle with deep and narrow V-shaped distal incision; the length of axis is the same as that of the posterior arms of the plate.

Holotype (♂): Ta-shu-lan, Shaowu Hsien, Fukien, April 24, 1944 (Maa); in Museum of National Foochow University, Foochow. Allotype (♀): Li-chia-tun, Kienyang Hsien, Fukien, April 18, 1945 (Maa); in Museum of National Foochow University, Foochow. Paratypes: 2♀♀, same collecting data as holotype, in Museum of National Foochow University, Foochow: 2♂♂, 5♀♀, same locality as holotype, April 20-May 8, 1942-1945 (Maa and Lin), in Maa collection; 1♀, same collecting data as holotype, in Museum of Comparative Zoology; 1♂, 1♀, San-chiang, Chungan Hsien, Fukien, May 8-19, 1943 (Maa), in Cheng Collection, Taipeh.

I have named this species in honor of Mr. Maa, who has been so kind as to allow me the loan of his collection.

This species somewhat resembles *Neopanorpa mutabilis* n. sp., but the gray color of the wing markings, the shorter last few abdominal segments of the male and the short axis of the female internal skeleton make its recognition easy.

Neopanorpa banksi Carpenter

Figures 177, 181

Neopanorpa banksi Carpenter, 1938, Proc. Ent. Soc. Washington, **40**(9): 275, figs. 25, 26.

Body mostly black above; vertex black; last few abdominal segments brown, the others black above. Fore wing: length, 15 mm.; width, 3 mm.; membrane hyaline; markings sooty brown; pterostigmal band interrupted, with same broad basal branch, but no apical branch; basal band reduced to a few spots; apical band entire, but narrowed posteriorly. Hind wing: similar to the fore. Female genitalia: subgenital plate broad, with a small U-shaped distal incision; internal skeleton large, the axis absent, but with three well developed plates at the base of the long, posterior arms, which reach to the tip of the subgenital plate.

Male unknown.

Holotype (♀): Suifu, Szechwan (D. C. Graham); in U. S. National Museum.

Distribution: same as holotype.

This species, having distinct wing markings, differs from other described *Neopanorpa* by the peculiar shape of the internal skeleton, which has three plates at the base of the long posterior arms.

Neopanorpa varia Cheng

Figures 214, 215, 294

Neopanorpa varia Cheng, 1949, Psyche, **56**(4):157, figs. 41, 42, 56.

Body light brown, black above, last few abdominal segments brown; vertex entirely black; rostrum light brown, with black stripe on each side. Fore wing: length, 14 mm.; width, 3.2 mm.; membrane hyaline, markings sooty brown; pterostigmal band

complete, with a separated basal branch and a narrow apical branch; apical band complete; pterostigma prominent. Hind wing: length, 13 mm.; width, 3.3 mm.; similar to fore wing, except that the basal band is represented by a small marking on the hind margin. Female genitalia: subgenital plate broad, with a U-shaped distal incision; internal skeleton large, U-shaped, posterior arms rather long, obtuse distally, very large basally, with a narrow selerotized bridge and a rounded membranous portion between them; axis apparently absent.

Male unknown.

Holotype (♀): Heierhwan (100 miles south of Tachienlu), Sikang, Sept. 20, 1939 (F. Y. Cheng, Io Chou and Tein Ho Hei); in Cheng Collection, Taipeh.

Distribution: Heierhwan, Sikang, Sept. 20, 1939; Jihti (20 miles east of Tachienlu), Sikang, Sept. 9, 1939; Wantung (50 miles south of Tachienlu), Sikang, Sept. 17, 1939.

This species is somewhat variable with regard to the markings of the wings. In my collection, there is one individual collected in Wantung, Sikang, with a greatly reduced pterostigmal band on both fore and hind wings and without the basal band on the hind wing.

The wings of this species resemble those of *Neopanorpa dimidiata* Navas superficially. However, in *dimidiata* the apical band is well developed, with a faint hyaline spot, whereas that of *varia* is interrupted posteriorly and without a hyaline spot. Moreover, the body color of these two species differs very much.

Neopanorpa cantonensis n. sp.

Figures 175, 179, 302

Body mostly black: vertex blackish brown, with a black mark enclosing ocelli; rostrum reddish brown, with blackish brown longitudinal stripe on each side; thorax brown laterally, with some obscurely blackish brown maculations, meso- and metanotum brown, with very broad blackish brown median streak; the 1st to 6th abdominal segments of female black dorsally, last few segments yellowish brown. Fore wing: length, 13 mm., width, 3 mm.; membrane hyaline, markings blackish brown; pterostigmal band very broad, complete, with broad basal branch and apical

branch; basal band complete; apical band large, connected with pterostigmal band at the costal margin; both basal and marginal spots present, elongated; pterostigma not prominent. Hind wing: length, 12 mm.; width, 2.9 mm.; similar to fore wing, except that both basal and marginal spots are entirely lacking. Female genitalia: subgenital plate broad at the middle portion, with wide V-shaped distal incision; internal skeleton small, U-shaped, posterior arms rather sharp distally, their basal outer margins smoothly curved, connected to each other by a bridge, which is covered by a rounded large membranous part; no axis present.

Male unknown.

Holotype (♀): Canton, Kwangtung; in Heude Museum, Shanghai.

This species differs from other described *Neopanorpa* by its very broad wing markings and the presence of the basal spot. The peculiar structures of the female genitalia also make its recognition easy.

Neopanorpa dimidiata Navas

Neopanorpa dimidiata Navas, 1930, Notes d'Ent. Chin. Mus., 1(6):2, fig. 1.

Vertex black, with a rusty yellow line running lengthwise near the eyes; rostrum yellowish brown, with a black spot on its upper surface; thorax dull yellow, with a deep black median band dorsally; 1st to 6th abdominal segments dull yellow, with a broad median band running lengthwise on the dorsum, the last few abdominal segments dirty yellow. Fore wing: length, 15.5 mm.; apex of wing rounded in an elliptical fashion; membrane appears smudged or very lightly touched with rust; markings sooty brown; pterostigmal band broad, with complete apical branch, which is narrow posteriorly; basal branch of pterostigmal band interrupted, represented by a spot at the anal margin of the wing; basal band absent; apical band broad, complete, with curved inner border and a faint window posteriorly. Both basal and marginal spots are absent; veins black and strongly developed. Hind wing: length, 15 mm.; similar to the fore. Female genitalia have not been worked out.

Male unknown.

Type (♀): Yunnan; originally in Navas Collection.

Distribution: same as type.

This species resembles *Neopanorpa varia* Cheng in the structure of the pterostigmal band of the wing, but differs in the apical band. In *varia*, the apical band is interrupted posteriorly, without a hyaline spot, whereas that of *dimidiata* is well developed, with a faintly hyaline spot posteriorly. I have not seen this species. The above account is based upon Navas' original description.

Neopanorpa pulchra Carpenter

Figures 182, 183

Neopanorpa pulchra Carpenter, 1945, Psyche, **52**(1-2):75, text-fig. 6, pl. 11, fig. 12.

Body light brown, slightly darker above. Fore wing: length, 14 mm.; width, 3 mm.; membrane hyaline, markings grayish brown; pterostigmal band broad, complete, with broad basal branch and narrower apical branch; basal band complete; apical band wide and entire, contiguous with pterostigmal band along costal margin; basal spot absent; marginal spot present, small; pterostigma not very prominent. Hind wing: length, 12.5 mm.; width, 3 mm.; similar to fore wing. Female genitalia: subgenital plate broad, with a shallow distal notch; internal skeleton broader than long, with widely divergent arms and no axis.

Male unknown.

Holotype (♀): Ta-han, Hainan Island, Kwangtung, June 23, 1935 (L. Gressitt); in Museum of Comparative Zoology.

This species has the general wing pattern of *Neopanorpa cantonensis* n. sp., but the wing is more slender and the basal spot is absent. It also resembles *N. parva* Carpenter superficially, but has more extensive markings. The internal skeleton of this species differs from that of *parva* by the widely divergent arms.

Neopanorpa parva Carpenter

Figures 184, 185

Neopanorpa parva Carpenter, 1945, Psyche, **52**(1-2):73; text-figs. 3, 5, pl. 11, fig. 13.

Body light to dark brown; vertex, thoracic nota and abdom-

inal tergites darker. Fore wing: length, 11-13 mm.; width, 2-2.8 mm. (holotype, length, 11 mm.; width, 2 mm.); membrane hyaline, markings grayish brown; pterostigmal band wide, with broad basal branch and narrower apical branch; basal band interrupted, represented by two narrow bands; apical band broken posteriorly; basal spot absent; marginal spot appearing as an elongated narrow band. Hind wing: length, 10 mm.; width, 2 mm. (holotype); similar to the fore. Female genitalia: subgenital plate rather broad, with a wide U-shaped distal incision; internal skeleton small, with nearly parallel arms and very short median axis.

Male unknown.

Holotype (♀): Kwanshien, Szechwan, July 16, 1937 (G. Liu); in Museum of Comparative Zoology.

Distribution: same as holotype.

This species has wing markings resembling those of *Neopanorpa cavaleriei* Navas, but it is much smaller than the latter and the wing membrane is hyaline, not slightly yellowish as in *cavaleriei*. The short median axis of the internal skeleton of the female makes its recognition easy.

Neopanorpa chaoi n. sp.

Figures 174, 178

Body yellowish brown; vertex deep brown with a sooty brown mark enclosing ocelli; rostrum reddish brown frontally, yellowish brown laterally; thorax yellowish brown laterally with few black spots, deep brown dorsally, meso- and metanotum with a median longitudinal sooty brown streak; 1st to 6th abdominal segments of female deep brown dorsally, last few segments reddish brown. Fore wing: length, 12.5 mm.; width, 3.2 mm.; membrane hyaline, markings brown; pterostigmal band complete with broad basal branch and apical branch; basal band complete; apical band prominent with two hyaline spots and partly united with the pterostigmal band at the pterostigmal area; basal spot present, two in number; marginal spot band-like, united with the basal band at the median portion of wing; pterostigma not prominent. Hind wing: length, 11.2 mm.; width, 3.1 mm.; similar to fore wing, except that the basal band

is not so developed and both basal and marginal spots are entirely lacking. Female genitalia: subgenital plate rather broad with a wide V-shaped distal incision; internal skeleton small, V-shaped, posterior arms blade-shaped with rather sharp posterior ends and stout bases which are connected to each other by a small strongly sclerotized bridge and a large membranous part; no axis present.

Male unknown.

Holotype (♀): Li-chia-tun, Kienyang Hsien, Fukien, Aug. 11, 1945 (Maa); in Museum of National Foochow University, Foochow. Paratypes: 3♀♀, Ta-chu-lan, Shaowu Hsien, Fukien, May 21-June 9, 1942-1943, 1♀, Yao-tou, Kienyang Hsien, Fukien, June 11, 1942 (Maa), in Maa collection; 1♀, Ta-chu-lan, Shaowu Hsien, Fukien, May 6, 1943 (Maa), in Museum of Comparative Zoology; 1♀, same collecting data, in Cheng Collection, Taipeh.

I have named this species in honor of Dr. Hsiu Fu Chao, who has been so kind as to allow me to borrow the material from the Museum of National Foochow University.

This species, having brown and extensive markings, is easily recognized by its double hyaline spots of the apical band and the small V-shaped internal skeleton of the female.

Neopanorpa latipennis Cheng

Figures 199, 203, 297

Neopanorpa latipennis Cheng, 1949, Psyche, **56**(4):156, figs. 39, 40, 55.

Body deep brown, black above, vertex black anteriorly, brown posteriorly, with a sooty brown marking on the median portion; rostrum brown, with a sooty brown median stripe on its lower portion. Fore wing: length, 14 mm.; width, 3.53 mm.; membrane hyaline, markings sooty brown; pterostigmal band very broad, with broad basal branch and narrower apical branch; basal band narrow and uneven, extending to the median portion of the wing; apical band large, represented by a big marking and an inner small Y-shaped band, the latter connected with the former to form a large hyaline spot; marginal spots small; pterostigma prominent; the wing apex rather broad. Hind wing: length, 12.55 mm.; width, 3.5 mm.; similar to fore wing, except

that the apical branch of the pterostigmal band, the inner small Y-shaped band of the apical band and the basal band are greatly reduced. Female genitalia: subgenital plate abruptly narrow posteriorly, with a wide U-shaped distal incision; internal skeleton small, being U-shaped, with a rather long stalk at its base, the axis apparently absent.

Male unknown.

Holotype (♀): Moupin, Sikang, July 29, 1941 (Chuan Lung Lee); in Cheng Collection, Taipeh.

This species, having a large hyaline spot in the posterior part of the apical band of the fore wing, differs from the other described *Neopanorpa* by the shape of the internal skeleton of the female.

Neopanorpa carpenteri n. sp.

Figures 176, 180, 300

Neopanorpa cavalerici, Navas, Carpenter, 1945, Psyche, **50**(1-2):74, text figs. 4, 7.

Head chestnut brown, vertex with blackish brown spot between ocelli; rostrum chestnut brown with reddish brown tip; thorax and abdomen blackish brown dorsally, reddish brown ventrally. Fore wing: length, 15 mm.; width, 3.7 mm.; membrane light yellow, markings sooty brown; pterostigmal band complete, with broad basal branch and narrower apical branch; basal band narrow, uneven; apical band large, with a large hyaline spot posteriorly and an oblique prolongation in the middle, not connected along the anterior margin with the pterostigmal band; basal spot absent; marginal spot appears as a long and narrow band and is connected to the basal band at the middle of the wing; pterostigma prominent; longitudinal veins and basal crossveins blackish brown, apical crossveins not very distinct, R_{2a} simple, not forked. Hind wing: length, 13.5 mm.; width, 3.8 mm.; similar to fore wing, except that the apical band is interrupted posteriorly, the basal band is reduced to one spot on the hind margin of wing and the marginal spot is entirely absent. Female genitalia: subgenital plate rather broad, with shallow V-shaped distal incision; internal skeleton small, with blade-like and twisted posterior arms, no true axis present.

Male unknown.

Holotype (♀): Yim-na-shan, East Kwangtung, June 16, 1936 (L. Gressitt); in Museum of Comparative Zoology.

Distribution: same as holotype.

I take the liberty of naming this species in honor of Professor F. M. Carpenter. The species resembles *Neopanorpa cavaleriei* in appearance, but differs in the apical band of the fore wing. In *cavaleriei*, the apical band is interrupted posteriorly and is connected along the anterior margin with the pterostigmal band, whereas that of this species is not interrupted, has a large hyaline spot and is separated from the pterostigmal band on the anterior margin of the wing. The R_{2a} vein of *cavaleriei* is forked into R_{2a1} and R_{2a2}, whereas that of this species is simple. Moreover, the basal band of *cavaleriei* is interrupted, whereas that of this species is complete and distinct.

Genus LEPTOPANORPA McLachlan

Leptopanorpa McLachlan, 1875, Trans. Ent. Soc. London, 1875:187. Weele, 1909, Notes Leyden Mus., **31**:11. Enderlein, 1910, Zool. Anz., **35**:393. Miyake, 1913, Journ. Coll. Agr. Imp. Univ. Tokyo, **4**:381. Esben-Petersen, 1913, Notes Leyden Mus., **35**:228. *Id.*, 1921, Coll. Zool. Selys Long. **5**(2):85. Lieftinck, 1936, Treubia, **15**(3):271.

Himanturella Enderlein, 1910, Zool. Anz., **35**:392.

Neopanorpa Enderlein, 1912, Notes Leyden Mus., **34**:237 (*nec* Weele).

Rostrum long and slender; tarsal claws serrated on inner margins; wings are fully developed, slender and narrow, especially at the base; 1A short, extending to the anal margin of wing far before origin of the radial sector; abdomen very long and slender in male, much longer than the wings; 6th to 8th abdominal segments of male much prolongated; genital bulb of male with a narrow stalk basally (pedunculate).

Genotype: *Leptopanorpa ritsemae* McLachlan.

This genus, which inhabits mostly southeast Asia, especially Japan and Java, is represented in China by only one species, *L. javanica* (Westwood); the Chinese locality of this species is Hainan, an island, which is separated from the mainland by a narrow sea.

The most obvious difference between *Leptopanorpa* and *Neopanorpa* is the length of the last four abdominal segments of the

male. However, the genital structures of both the male and the female of *Leptopanorpa* are quite close to *Neopanorpa*. In some species of *Leptopanorpa*, e.g., *longicauda*, the last four abdominal segments of the male are exceedingly long, in others, e.g., *erythrura*, they are rather short. It seems to me that there is no distinct difference between *Leptopanorpa* and *Neopanorpa*. Whether or not this characteristic (prolongation of the last four abdominal segments of the male) is of generic significance is not certain. A morphological study of the larva of this genus and that of *Neopanorpa* would be a great help in settling the question. A knowledge of the life history and feeding habits of the *Leptopanorpa* is also very desirable.

Leptopanorpa javanica (Westwood)

Figures 228, 229

Leptopanorpa javanica (Westwood) Esben-Petersen, 1913, Notes Leyden Mus. **35**:229. *Id.*, 1915, Ent. Medd., **10**:231, cat.-no. 9. *Id.*, 1921, Coll. Zool. Selys Long., **5**(2):89, fig. 100. Lieftinck, 1936, Treubia, **15**(3): 315, pls. 6, 7, 10, 12, 14.

Panorpa javanica Westwood, 1846, Trans. Ent. Soc. London, **4**:186. *Id.*, 1852, Trans. Ent. Soc. London, **1**(2):5. Walker, 1853, Cat. Neur. Ins. Brit. Mus., 1853:460. Weele, 1909, Notes Leyden Mus. **31**:6.

Campodoteenum javanicum Enderlein, 1910, Zool. Anz., **35**:391. *Id.*, 1912, Notes Leyden Mus., **34**:236.

Head black; rostrum reddish brown; thorax black above, sides grayish testaceous to pitchy black; abdomen of female black above, terminal segments and the venter paler; 1st to 5th abdominal segments of male black, last few segments dark pitchy brown; the hind border of third tergite extending into a slender cylindrical prolongation which reaches the middle of next segment, where a tubercle is found; 6th segment cylindrical, 7th and 8th slender, much thinner than 6th, of equal length and one and a half times longer than 6th; their apical part gradually incrassate towards the apex, which is obliquely truncated above; 9th segment pedunculate. Fore wing: length, 9-10.5 mm.; slender with elliptical apex; membrane whitish, markings sooty black; pterostigmal band complete, with a broad basal branch and a very narrow apical branch; basal band interrupted, represented by two spots; apical band broad, with nearly straight inner

margin, sometimes enclosing a whitish spot in its posterior part; along the front margin it is narrowly connected with the pterostigmal band; basal spot absent; marginal spot present; pterostigma not prominent. Hind wing: length, 8-9 mm.; similar to the fore, except that the basal band is represented by only one spot. The male genitalia have been figured out by Lieftinck. According to his drawings, the genital bulb is slender; coxopodites rather long, with truncated apex; harpagones long, slender, smoothly incurved at apices, the outer margin slightly concave near the base, the inner margin with a basal rounded tooth and two lobes, opposite each other; hypandrium conspicuous, broad; hypovalvae broad, with rounded apex, reaching beyond the base of harpagones, the distal portion of hypovalvae coming into contact with each other; parameres simple, with slender and twisted stalk and a greatly enlarged apical portion (if I understand Lieftinck's drawing correctly); preëpiproct with rounded tip; aedeagus with well developed and stout apical processes; lateral processes curved backward and inward with broad apex. The internal skeleton of the female genitalia has been figured by Lieftinck. According to his drawing, the internal skeleton is very short and comparatively broad; the basal portion of the plate is in the form of two wing-like structures, which are rather twisted and turned dorsad; mesially the two portions converge and are connected with each other by a thin membrane; the distal portion of the plate well demarcated; posterior arm of the plate short, with tooth-like apex; axis not present.

Types (♂, ♀): Java (D. Horsfield); in Mus. Soc. Merc. Ind. Orient.

Distribution: Mt. Wuchi, Hainan, Kwangtung, May 21, 1903; Leito, Burma (Leonardo Fea); Carin Chebai, Burma (900-1100 m.), Dec. 5, 1888 (Leonardo Fea); Sumatra (Ericson); Java (Horsfield); Banjoemas, Noesa, Mid. Java, no. 10, 1925-1928 ("teak forest," L. G. E. Kalshoven); coastal forest around Sempoertjondong (Tjidaoen), 100 m., S. W. Java, Sept. 5, 1935 (Max Bartels, Jr.).

This is the only known species in China. It resembles *L. peterseni* Lieftinck (East Java) in body and wing color. However, according to Lieftinck's drawings, the male genitalia of this species are quite different from those of *peterseni*, especially the

shape of the hypovalvae. The axis of the female internal skeleton of this species is apparently absent, whereas that of *peterseni* is well developed.

Family BITTACIDAE

Bittacidae Enderlein, 1910, Zool. Anz., **35**:387. Esben-Petersen, 1921, Coll. Zool. Selys Long. **5**(2):115, fig. 126. Carpenter, 1931, Bull. Mus. Comp. Zool., **72**(6):257.

Ocelli present; labial palpi two-segmented; abdomen narrowly cylindrical; females without ovipositor; terminal segments of male only slightly modified; legs tenuate, with a single tarsal claw, modified for grasping; wings usually subpetiolate, slender; costal space narrow, with few crossveins; R_s originating at two-fifths to one-half the wing length from base; M dividing near the middle of the wing.

Bittacus is the only one of the six existing genera of the family which inhabits China.

Genus BITTACUS Latreille

Bittacus Latreille, 1805, Hist. Nat. Crust. et Ins., **8**:20. *Id.*, 1807, Gen. Crust. et Ins., **3**:189. Klug, 1836, Abh. Königl. Akad. Wiss. Berlin, 1836:97. Burmeister, 1839, Handb. Ent., **2**:955. Rambur, 1842, Hist. Nat. Ins. Nevr., 1842:326. Brauer, 1855, Verh. Zool.-bot. Ges., **5**:707, pl. 2. *Id.*, 1863, Verh. Zool.-bot. Ges., **21**:109, p. 3. Brauer and Löw, 1857, Neuropt. Austr., 1857:36. Felt, 1896, New York State Ent. Rep., **10**:463, pls. 3, 4. Hine, 1898, Journ. Columb. Horticult. Soc., **12**:105, pls. 1, 2. McClendon, 1906, Ent. News, 1906:121, fig. 15. Klapálek, 1910, Acta Soc. Ent. Bohem., **7**:114. Enderlein, 1910, Zool. Anz., **35**:396. Esben-Petersen, 1913, Revue Zool. Afr., **3**:135. Banks, 1913, Trans. Amer. Ent. Soc., **39**:233. Lestage, 1917, Revue Zool. Afr., **5**:112. Esben-Petersen, 1921, Coll. Zool. Selys Long., **5**(2):117. Carpenter, 1931, Bull. Mus. Comp. Zool., **72**(6):257.

Leptobittacus Hine, 1898, Journ. Columb. Horticult. Soc., **12**:108.

Thyridates Navas, 1908, Mem. Real. Acad. Ciene. Art. Barcelona, 1908:412.

Diplostigma Navas, 1908, Mem. Real. Acad. Ciene. Art. Barcelona, 1908:413.

Haplodictyus Navas, 1908, Mem. Real. Acad. Ciene. Art. Barcelona, 1908: 413. *Id.*, 1908, Rev. Russe d'Ent., 1908:277.

Eyes widely separated below antennae; basal segment of hind tarsus longer than fourth segment; wings present, their mark-

ings appearing as spots, without bands; one costal crossvein; 1A of hind wing coalescing with Cu_2 for a short distance.

Genotype: *Bittacus italicus* O. F. Müller.

This is the second largest genus of Mecoptera, including sixty-two known species in the whole world. Seven species have already been recorded in China and four new ones are described below, making a total of eleven. They are widely distributed in that country. Although only eleven species have been found, the localities cover the whole mainland of China, that is, from northern Shensi, Liaoning (one province of Manchuria) to southern Kwangtung, Yunnan, and from western Sikang to eastern Kiangsu. Some species, e.g., *sinensis* Walker, besides being common in Kiangsu, Chekiang, have also been recorded in Korea and Japan.

In the classification of the species of *Bittacus*, the chief characteristics which have been used are the body structure and wing coloration. In some species, the wing membrane is yellow (*sinensis*, etc.), in others, light brown (*sinicus*, etc.). The size of the wing affords some specific characters; in *appendiculatus*, the fore wing is shorter than 17 mm., whereas that of *sinensis* is longer than 24 mm. The apex of the wing of most species is obtusely angulated, but in *carpenteri* n. sp., it forms nearly a right angle, forming a prominent corner. The wing markings usually appear as several small spots. They are present in all the species, except *planus* and *appendiculatus*. Most of the venational characteristics are subject to individual variation. However, there are some venational features which are of use and value in the determination of species, especially for the female: the position of the ending of 1A and that of cubital crossvein (Cuv) with respect to the fork of media (M); the presence or absence of the anal crossvein (Av); and the number of pterostigmal crossveins (Pcv).

Another important characteristic is the structure of the male genitalia, which are not so complex as those of Panorpidae. The tergum of the 9th abdominal segment is deeply cleft posteriorly, forming a pair of claspers. The shape of this appendage varies in different species. Seen from the side, it is triangular in some species (*triangularis*, fig. 233) and subquadrangular in others (*sinicus*, fig. 245). Some species have a caudal incision in each

of the claspers (*sinensis,* fig. 235), whereas others have a single long process (*carpenteri* n. sp., fig. 246). In most species, the posterior parts of the inner surface of the claspers have a patch of short, stout, sooty-brown bristles (*sinensis,* etc., fig. 255), others have no bristles at all (*carpenteri* n. sp., fig. 256), and others have two to three bristles which are borne on lobes attached to the median, inner surface of the claspers. The sternum of the 9th segment is a simple semicircular plate. It is not of much use for identification. The coxopodites are reduced, mostly fused with the 9th sternum. The harpagones are also greatly reduced. However, the shape of this small appendage varies in different species. In some species, the outer margins of the harpagones are concave (*sinicus,* etc., fig. 249) and in others convex, forming a prominent process (*pieli,* fig. 250). Some appear as an inverted boot, others have a long and slender distal process (*planus,* fig. 248). Extending upward between the coxopodites is a long coiled spiral filament or filum. A pair of prominent lobes, the aedeagus lobes, project upwards on each side of the base of the filament. In some species, they are long and slender (*tienmushana* n. sp., fig. 268) and in others short and stout (*pieli,* fig. 250). Some have a rounded apex (*sinensis,* fig. 270), others have the apex truncated (*planus,* fig. 248). The proctiger which extends dorso-caudad between the precpiproct and the coxopodites affords some taxonomic value. In some species, it is long and slender (*carpenteri* n. sp., fig. 262) and in others short and stout (*gressitti* n. sp., fig. 254). Some have a pair of lateral lobes at the middle (*coreana,* fig. 240), while others have a pair of long processes on the dorsal part of the apex (*tiennmushana* n. sp., fig. 263). The lower process of the proctiger varies much in degree of development. In some species, it is very long (*carpenteri* n. sp., fig. 262), in others, it is very short (*gressitti* n. sp., fig. 254).

The females of *Bittacus* seem to have lost the internal skeleton which is so useful in the taxonomy of the Panorpidae. The subgenital plate is not well-developed, and no taxonomic value can be found. Therefore, the identification of females is based only upon the general body and wing characteristics.

Key to the Species of Bittacus

1. Wing membrane yellowish 2
   Wing membrane light brown or brown 6
2. Fore wing length shorter than 17 mm. or longer than 24 mm. 3
3. Wing membrane slightly yellowish; length of fore wing shorter than 17 mm.; preëpiproct extending upward, with pointed dorsal process and an upwardly curved caudal process ..... *appendiculatus*
   Wing membrane strongly yellowish; length of fore wing longer than 24 mm.; preëpiproct extending posteriorly, deeply cleft at the apex, with upper branch and lower branch ..... *sinensis*
4. Preëpiproct cleft at the apex, the upper branch less developed, lower branch elongated, broadening towards its apex which is curved inwards; proctiger with a pair of median lateral lobes ..... *corcanus*
   Preëpiproct not cleft at the apex 5
5. Preëpiproct triangular when viewed from side; proctiger with a pair of side lobes located close to its apex ..... *triangularis*
   Preëpiproct not triangular when viewed from side, with more or less truncated posterior margin; proctiger without paired side lobes .... *planus*
6. Prëpiproct more or less triangular when viewed from side 7
   Preëpiproct not triangular when viewed from side 8
7. The posterior part of the ventral portion of preëpiproct extends posteriorly to form a process; aedeagus lobes long, with rather sharp tips; dorsal apical half of proctiger with a pair of side lobes .... *zoensis* n. sp.
   The posterior part of the ventral portion of preëpiproct less extended; aedeagus lobes very long, with truncated apex; dorsal apical part of proctiger with a pair of processes ..... *tienmushana* n. sp.
8. Preëpiproct with prominent posterior process when viewed from side..9
   Preëpiproct without posterior process when viewed from side 10
9. Prëepiproct irregularly quadrangular when seen from side, with a very long posterior process at the dorsum of its posterior margin; both proctiger and lower process long and slender; apices of wings appearing as a right angle..... *carpenteri* n. sp.
   Preëpiproct more or less quadrangular when seen from side, with the caudal margin cleft, the upper branch short, while the lower branch greatly extends posteriorly to form a process with rounded tip; both proctiger and lower process short and stout; apices of wings not appearing as a right angle ..... *gressitti* n. sp.
10. Preëpiproct subquadrangular, no lobes at its inner side; outer margins or harpagones not convex ..... *sinicus*
    Preëpiproct irregular in shape, with two lobes on its median inner side; outer margins of harpagones very much convex ..... *pieli* n. sp.

Descriptions of Species of Bittacus

Bittacus appendiculatus Esben-Petersen

Figure 230

Bittacus appendiculatus Esben-Petersen, 1927, Notul. Ent. 7:14, figs. 3, 4.

Body brown; vertex with a black spot enclosing ocelli. Fore wing: length, 16 mm.; rather narrow, with smoothly angulated apex; membrane with yellowish tinge, no markings present; veins brown, Sc terminating near the middle of the costal margin. 1A very short, ending on the anal margin far before the level of the fork of M; cubital crossvein (Cuv) present, located before the fork of media; no anal crossvein (Av) present; pterostigma prominent, short, almost triangularly shaped, yellowish brown, connected with R_s by one pterostigmal crossvein (Pcv). Hind wing: length, 16 mm.; similar to the fore, except that the first anal is a little longer. Male genitalia: I have not seen this species; however, according to Esben-Petersen's drawing, the preëpiproct is very broad and short in lateral view, extending upwards, rather than posteriorly, with a prominent pointed dorsal process; the anterior margin of the preëpiproct is strongly sinuous, the posterior margin straight, with upwardly curved posterior processes which extend from the lower margin of the preëpiproct; coxopodites prominent, harpagones ax-shaped; both proctiger and lower process narrowed towards apex.

Type (♂): San-nen-kai, Yunnan; in Esben-Petersen Collection, Silkeborg.

Distribution: same as type.

This species, having light yellowish wing membranes, differs from the other described *Bittacus* by the dorsally extended preëpiproct of the male genitalia.

Bittacus sinensis Walker

Figures 235, 237, 255, 270, 303

Bittacus sinensis Walker, 1853, Cat. Neur. Ins. Brit. Mus., 1853:469. McLachlan, 1887, Mitt. Schweiz. Ent. Ges., 1887:406. Miyake, 1913, Journ. Coll. Agr. Imp. Univ. Tokyo, 4:386. Navas, 1913, Notes d'Ent. Chin. 1(7):4. Esben-Petersen, 1921, Coll. Selys Long., 5(2):121, figs. 132, 133. Okamoto, 1925, Bull. Agr. Exp. Sta. Gov. Chosen, 2(1):8.

Diplostigma sinense Navas, 1908, Mem. Real Acad. Ciene. Art. Barcelona, 1908:413. *Id.*, Rev. Russe d'Ent., 1909:277.

Bittacus quaternipunctatus Enderlein, 1910, Zool. Anz., 1910:397. Miyake, 1913, Journ. Coll. Agr. Imp. Univ. Tokyo, **4**:387. pl. 33, fig. 6, pl. 37 fig. 10.

Bittacus strategus Navas, 1913, Bull. Mus. d'Hist. Nat., Paris, 1913:442, figs. 2a, 2b.

Head pale brown, vertex with black spot between ocelli; rostrum fuscous with paler tip; thorax and abdomen pale brown. Fore wing: length, 24-26 mm.; width, 6-6.3 mm.; rather broad with more or less rounded apex; membrane strongly yellowish, with four minute dark brown spots, one at the fork where M separated from Cu_1, one at the base of R_s, one at the subcostal crossvein (Scv) and one at the first fork of R_s; veins yellowish brown, 1A terminating at the level of the fork of M, some of the crossveins in the apical part faintly and narrowly brownish shaded; both cubital crossvein (Cuv) and anal crossvein (Av) present, the former a little beyond the fork of media; pterostigma rather prominent, subquadrangular, yellowish, connected with R_s by one or two pterostigmal crossveins (Pcv). Hind wing: length, 21-23 mm.; width, 5.5-6 mm.; similar to fore wings. Male genitalia: the dorsal margin of the preëpiproct when viewed from side, convex, deeply cleft at the tip; lower branch of this cleft larger than the upper one, curved inwards, both lower and upper branches with rounded apex and with a series of short black bristles on their interior side; caudal end of coxopodites concave; harpagones short, with inner process; aedeagus lobes on each side of the base of filum (spiral filament) narrow and slender; proctiger rather truncated at the apex, furnished with a bundle of hairs, no lateral lobe present; lower process also truncated at the apex.

Type (♀): Shanghai, China (Saunders 68:3); in the type-series of Walker, Museum of London.

Distribution: same as type: Soochow (Wuhsien), Kiangsu; Shanghai, Kiangsu; Chusan, Chekiang, June 3-4, 1934-35; Suigen, Korea, June to July, 1922; Shakuofi, Korea, July, 1922; Tokyo, Japan.

This species differs from other described *Bittacus* by its strongly yellowish wing membrane. The apex of the preëpiproct of this species is deeply cleft as in *B. coreanus* Issiki, but the

upper branch of this species is more developed than that of *coreanus*.

Bittacus coreanus Issiki

Figures 234, 240, 247, 251, 309

Bittacus coreanus Issiki, 1929, Trans. Nat. Hist. Soc. Formosa, **19**(102): 304, text-fig. 20.

Head brownish yellow, the area between the ocelli blackish; rostrum fuscous, with yellowish tip; thorax and abdomen yellowish brown or grayish brown, each basal tergite of abdomen with a very narrow, black, median, transverse band on the hind border. Fore wing: length, 22 mm.; width, 5.5 mm.; broadened towards the apical area, with obtuse tip; membrane with yellowish tinge; markings appear as minute blackish brown spots, four in number, one at the fork where M separates from Cu, one at the base of R_s, one at subcostal crossvein (Scv) and one at the first fork of R_s; besides these, there is a very feeble spot at the fork of R_{4+5}; of all the spots, the first two are more distinct; veins brown, some of them yellowish; 1A ending on the anal margin a little beyond the fork of M; crossveins in the apical part of wing faintly and narrowly brownish shaded, cubital crossvein (Cuv) a little beyond the fork of media, anal crossvein (Av) between Cu_2 and 1A absent; pterostigma not prominent, connected with R_s by two crossveins (Pcv). Hind wing: length, 20 mm.; width, 4.7 mm.; similar to fore wings. Male genitalia: the dorsal margin of preëpiproct more or less rounded when viewed from side, deeply cleft at the tip, lower branch of this cleft elongated, broadened towards apex, curved inwards, with a series of short black bristles on the interior side of the tip, upper branch also with short black bristles on the interior side of its apex; caudal end of coxopodites with V-shaped distal incision; harpagones short, with inconspicuous inner processes; aedeagus lobes on each side of the base of filum (spiral filament) short and broad, with rounded tips, reddish brown; proctiger truncated at the apex, the latter furnished with a few short hairs on its dorsal corner; at the middle of proctiger is a pair of lateral lobes, furnished with very short hairs; lower process short and narrowed towards apex.

Type (♂): Keizyo, Korea, June 24, 1926 (Issiki); in Issiki Collection.

Distribution: same as type; Suigen, Korea, June 23, 1926 (Issiki); Shanghai, Kiangsu, China, June 16-22, 1931-1933; Zikawei, Shanghai, Kiangsu, China, July 17, 1938 (Piel).

This species has previously been known only from Korea.

Coreanus, having a yellowish wing membrane, differs from other described *Bittacus* by the peculiar shape of its preëpiproct, which is deeply cleft at the tip; the upper branch of this cleft is short, the lower branch elongate, broadening towards the apex and curved inwards. The paired median lateral lobes of the proctiger also make its recognition easy.

Bittacus triangularis Issiki

Figures 233, 241, 252, 267, 310

Bittacus triangularis Issiki, 1929, Trans. Nat. Hist. Soc. Formosa, **19**(102): 306, text-fig. 21.

Body pale yellowish brown; vertex yellowish brown, with blackish brown marking between the ocelli and also between the antennae; rostrum blackish brown, with yellowish tip; the basal segments of the abdomen have very narrow blackish hind margin above. Fore wing: length, 20-21 mm.; width, 5.7 mm.; the wing apex rather obtuse; membrane with yellowish tinge; markings very small, blackish brown, three in number, one at the fork where M separates from Cu_1, one at the base of R_s and one at the first fork of R_s; veins yellowish brown; 1A terminating on anal margin near the level of the fork of M, crossveins in the apical half narrowly and slightly shaded with brown, subcostal crossvein (Scv) shaded with dark brown, cubital crossvein (Cuv) considerably beyond the fork of media, anal crossvein (Av) absent; pterostigma not very prominent, connected with R_s by two pterostigmal crossveins (Pcv). Hind wing: length, 18-19 mm.; width, 5 mm.; similar to fore wings. Male genitalia: preëpiproct triangular when viewed from side, the hind-margin slightly emarginate at the tip, the lower side of this emargination a little produced, and its inner surface without black bristles, while the apical part of the upper side has short black bristles on the inner surface; distal end of coxo-

podites conspicuously produced; harpagones comparatively long, with rounded tips; aedeagus lobes on each side of the base of filum (spiral filament) grayish yellow, rather long and broad, with rounded tips; apex of proctiger rounded, with long dense hairs; very close to the apex there is a pair of side lobes, which are furnished with soft hairs; the lower process long, well developed, with a few inconspicuous hairs on the dorsal surface.

Type (♂): Moukden (Shenyang), Liaoning, (one province of Manchuria), July, 1916 (A. Nohira); in Issiki Collection.

Distribution: same as type; Keizyo, Korea, June 24, 1926; Moukden, Liaoning, Aug., 1916.

This species, having a yellowish wing membrane, differs from the other described *Bittacus* by its triangular preëpiproct in side view and the peculiar structure of the proctiger.

Bittacus planus Cheng

Figures 239, 244, 248, 258, 305

Bittacus planus Cheng, 1949, Psyche, 56(4):158; figs. 59, 60, 61, 63, 67.

Body light brown, vertex brown, with a sooty brown marking enclosing ocelli; rostrum brown; mesothorax with two sooty brown spots on each side dorsally. Fore wing: length, 20.2 mm.; width, 5.2 mm.; the wing apex rather broad, apex obtusely angulated; membrane light yellowish brown, without markings; veins brown, 1A terminating a little before the level of the fork of M, crossveins very slightly emarginate, cubital crossvein (Cuv) located beyond the level of the fork of M, no anal crossvein (Av) present; pterostigma not very prominent, connected with R_s by two pterostigmal crossveins (Pcv). Hind wing: length, 17.5 mm.; width, 4.2 mm.; similar to fore wings, except that there is only one pterostigmal crossvein (Pcv). Male genitalia: preëpiproct with V-shaped inner margins when seen from above, with truncated apex; the apical margins slightly concave, furnished with a series of short black bristles on its inner sides; posterior end of coxopodites extending upward for a considerable distance, with smooth apex; harpagones broad basally, very narrow and slender distally, with prominent inner process; aedeagus lobes on each side of the base of filum (spiral filament) broaden towards apex, furnished with a bundle of

short hairs; the lower process very long, pointed towards its apex.

Holotype (♂): Mt. Taipai, Shensi, June, 1942 (Io Chou); in Cheng collection, Taipeh.

This species, having a yellowish brown wing membrane, differs from the previously described species by the more or less truncated caudal margins of the preëpiproct in lateral view. The slender harpagones and the broadened apex of the aedeagus lobes also make its recognition easy.

Bittacus zoensis n. sp.

Figures 231, 253, 257, 265, 306

Body brown, vertex deep brown, with sooty brown marking enclosing ocelli; rostrum blackish brown. Fore wing: length, 23.5 mm.; width, 5.8 mm.; rather broad, with obtusely angulated apex; membrane light brown, with six minute blackish brown spots; one at the fork where M separates from Cu_1, one at the base of R_s, one at the first fork of R_s, one at the subcostal crossvein (Scv), one at the fork of R_{4+5} and one at the pterostigmal crossvein (Pcv); veins brown; 1A terminating before the level of the fork of M, crossveins slightly shaded with brown, cubital crossvein (Cuv) one or two, located in the level of the fork of M, no anal crossvein (Av) present; pterostigma not prominent, connected with R_s by one or two pterostigmal crossveins (Pcv). Hind wing: length, 21 mm.; width, 5.4 mm.; similar to fore wings, except that both cubital and pterostigmal crossveins are represented by one crossvein. Male genitalia: preëpiproct equilaterally triangular when seen from side, the caudal margins slightly convex at the middle, the posterior parts of the ventral margin extending backward to form a prominent process; at the inner surface of the angle between the above margins are short black bristles; coxopodites slightly curved upward with emarginate apex; harpagones short, with rounded tips, the median inner margin with inner processes; aedeagus lobes on each side of the base of filum (spiral filament) rather long with rather sharp tips; proctiger with truncated apex, furnished with a bundle of brown hairs; on its apical half there is a pair of prominent side lobes, furnished with a row of long brown

bristles; the lower process rather short, pointed towards its apex.

Holotype (♂): Zo-se, Chungkiang-Hsien, Kiangsi; June 5, 1934; in Heude Museum, Shanghai. Paratypes: 1♀, same collecting data as holotype; in Museum of Comparative Zoology; 1♀, same collecting data as holotype; in Cheng Collection, Taipeh.

The male of this species has a triangular preëpiproct, as seen in lateral view, as in *Bittacus triangularis* Issiki, but the more equilateral form of the preëpiproct, the stout harpagones and the light brown wing membrane make its recognition easy.

Bittacus tienmushana n. sp.

Figures 232, 259, 263, 268, 304

Body blackish brown, vertex brown, with a black marking within ocelli; rostrum reddish brown. Fore wing: length, 25.5 mm.; width, 6 mm.; rather broad, with obtusely angulated apex; membrane light brown, with three minute blackish brown spots, one at the fork where M separates from Cu_1, one at the base of R_s and one at the first fork of R_s; veins brown; 1A terminating at the level of the fork of M, crossveins slightly shaded with brown, cubital crossvein (Cuv) located in the level of the fork of M, no anal crossvein (Av) present; pterostigma not very prominent, connected with R_s by two pterostigmal crossveins (Pcv). Hind wing: length, 21.5 mm.; width, 5.5 mm.; similar to fore wings. Male genitalia: preëpiproct equilaterally triangular when seen from side, the caudal parts of the ventral margins very slightly produced behind; at the inner surface of the lower area of the caudal margin are short black bristles; coxopodites slightly produced; harpagones short, inverted boot-shaped; aedeagus lobes on each side of the base of filum (spiral filament) long, with truncated apex and irregular outer margins; proctiger cone-shaped, with truncated apex; on the dorsal part of the apex, there is a pair of prominent long processes; the lower process rather long, pointed towards its apex.

Holotype (♂): Tien-mu-shan, Chekiang; July 11, 1936; in Museum of Institute of Zoology, Academia Sinica, Shanghai. Paratypes: 1♀, same collecting data and same location as holotype; in Museum of Comparative Zoology; 1♀, same collecting data as holotype; in Cheng Collection, Taipeh.

This species, having a light brown wing membrane, differs from *Bittacus zoensis* n. sp. by its less extended processes in the caudal-ventral portion of the preëpiproct.

Bittacus carpenteri n. sp.

Figures 246, 256, 262, 269, 307

Body light brown; vertex brown, with a deep brown marking enclosing ocelli; rostrum brown. Fore wing: length, 21.5 mm.; width, 5.5 mm.; narrow, with right angulated apex; membrane light brown, with several minute dark brown spots, one at the fork where M separates from Cu_1, one at the base of R_s, one at the first fork of R_s, one at the fork of R_{4+5} and one at the cubital crossvein (Cuv); veins brown, 1A terminating far before the level of the fork of M; the distal end of R_5 and most of the crossveins are heavily shaded with brown; cubital crossvein located before the fork of M, no anal crossvein (Av) present; pterostigma prominent, connected with R_s by two pterostigmal crossveins (Pcv). Hind wing: length, 17.5 mm.; width, 4.5 mm.; similar to fore wings. Male genitalia: preëpiproct irregular when seen from side, with a swollen caudal portion which has a very long caudal process; coxopodites with concave apex; harpagones very small, inwardly bent; aedeagus lobes on each side of the base of film (spiral filament) narrowed towards apex, with truncated tips; proctiger very long, slender at the middle portion, with enlarged apex which is furnished with a row of hairs; the lower process very long, pointed towards its apex.

Holotype (♂): Mt. Omei (11,000 ft.), Szechwan; July 21, 1935; D. C. Graham; in Museum of Comparative Zoology.

I take the liberty to name the species in honor of Professor F. M. Carpenter, who has allowed me to describe the species.

This species, having a light brown wing membrane, is easily distinguished from the other described *Bittacus* by the apex of the wing forming nearly a right angle and the long posterior processes of the preëpiproct. The very long and slender proctiger and lower process also make its recognition easy.

Bittacus gressitti n. sp.

Figures 236, 254, 260, 266, 312

Body deep brown; vertex black anteriorly; reddish brown posteriorly; rostrum blackish brown. Fore wing: length, 23.8 mm.; width, 5.3 mm.; membrane light brown, with some ill-defined reddish brown shadows along the margin of the apical portion of wing; markings minute, blackish brown, one at the fork where M separates from Cu_1, one at the base of R_s and one at the first fork of R_s; veins brown; 1A terminating at the level of the fork of M, crossveins rather heavily shaded with brown, cubital crossvein (Cuv) located a little beyond the fork of M, no anal crossvein (Av) present; pterostigma rather prominent, connected with R_s by two pterostigmal crossveins (Pcv). Hind wing: length, 21 mm.; width, 5 mm.; similar to fore wings. Male genitalia: preëpiproct U-shaped when seen from dorsal side, apparently emarginate at the tip, lower parts of this emargination much produced and not so curved inwards as in *Bittacus chujoi* Issiki and Cheng; upper parts short and thick; both the lower and upper parts are furnished with short black bristles on the interior sides; harpagones longer than that of *chujoi,* with broad bases, rounded tips and small inner processes; aedeagus lobes on each side of the base of filum (spiral filament) slender, pointed towards apex in caudal view; proctiger with its posterior half bent upward; apex truncated, with only very minute hairs; close to the apex there is a prominent side lobe covered with many soft hairs. Lower process short, but apparently present.

Holotype (♂): Yim-na-shan, E. Kwangtung; June 12, 1936; L. Gressitt; in Museum of Comparative Zoology. Paratypes: 5 ♀ ♀, same type locality and deposition as holotype; June 12-17, 1936; L. Gressitt; in Museum of Comparative Zoology.

This species is named in honor of the collector, Dr. L. Gressitt. It resembles *Bittacus coreanus* Issiki in the structure of the preëpiproct, but these two species are at once distinguished by the color of the wing membrane and the body size. This species is also closely allied to *B. chujoi* Issiki and Cheng from Formosa. The preëpiprocts of these two species have nearly the same shape when seen from the side. In *gressitti,* however, the lower

margins of the preëpiproct are wholly (not just partly, i.e., caudally, as in *chujoi*) folded outward and the lower process is much longer and extends straighter than that of *chujoi*. Besides this, the bare apex of the proctiger of this species is quite easy to distinguish from that of *chujoi*, which has an apical bundle of long hairs.

Bittacus sinicus Issiki

Figures 238, 245, 249, 264, 311

Bittacus sinicus Issiki, 1931, Ann. Mag. Nat. Hist., (10)7:221, fig. 2.

Head and rostrum blackish brown, posterior part of vertex paler; dorsum of thorax blackish brown, meso- and metathorax with a pale median longitudinal streak, scutella pale; abdomen blackish brown, becoming blackish towards apex, except the preëpiproct (9th tergite), which is pale brown. Fore wing: length, 17.5-19.3 mm.; width, 5 mm.; rather narrow, dilated posteriorly, apex obtusely angulated, hind margin conspicuously sinuate at the end of Cu; membrane brownish, apical margin darker; markings appear as four flecks, one at M, where it separates from Cu_1, one at the base of R_s, one at the first fork of R_s, and one at ending of Cu_2; 1A terminating on anal margin before the level of the form of M, crossveins (except in basal part of wing) shaded with blackish brown; three of these fall in a line from fork of R_{4+5} to near the end of Cu_1; passing the fork of M_{3+4}, their shading forms a narrow transverse streak; cubital crossvein (Cuv) a little before the fork of M, anal crossvein (Av) present; pterostigma rather short, not very prominent, connected with R_{2+3} by two pterostigmal crossveins (Pev). Hind wing: length, 15.5-17.5 mm.; width, 4.5 mm.; similar to fore wing. Male genitalia: preëpiproct with deep U-shaped inner margins, when seen from above, with rounded apex, viewed laterally, subquadrangular, upper and lower margin slightly concave, distal margin slightly convex, oblique and without cleft, furnished with a series of short black bristles along its inner sides; posterior end of coxopodites extending upward for a considerable distance, with emarginate apex; harpagones broad basally, narrow distally, with prominent inner process; aedeagus lobes on each side of the base of filum (spiral filament) short,

rather broad, rounded at apex; proctiger narrow, with tooth-like apex, furnished with a bundle of hairs; the lower process broad basally, narrowed towards apex.

Type (♂): Mt. Omei (4500 ft.) Szechwan, July 17, 1929 (Collector unknown); in Issiki Collection, Tokyo.

Distribution: same as type; Jihti (30 miles east of Tachienlu), Sikang, Sept. 2, 1939 (F. Y. Cheng).

This species, having a brownish wing membrane, differs from other described *Bittacus* by its subquadrangular preëpiproct (in side view) and its rather small body size.

Bittacus pieli Navas

Figures 242, 243, 250, 261, 308

Bittacus pieli Navas, 1935, Notes d'Ent. Chin. Mus. Heude, **2**(5):99, fig. 63. *Id.*, 1936, Notes, d'Ent. Chin. Mus. Heude, **3**(4):59, fig. 74.

Body dull brown; vertex with black marking enclosing ocelli; rostrum blackish brown. Fore wing: length, 22 mm.; width, 4.8 mm.; narrow and slender, with obtusely angulated apex; membrane light brown, markings grayish brown; of these markings three are prominent, one at the fork where M separates from Cu_1, one at the base of R_s and one at the first fork of R_s; the apical portion of the hind margin and the apex of wing heavily shaded with grayish brown; veins brown; 1A terminating on anal margin a little before the level of the fork of M, all the crossveins heavily shaded with grayish brown, cubital crossvein (Cuv) located a little before the fork of M, anal crossvein (Av) present; pterostigma prominent, connected with R_s by two pterostigmal crossveins (Pcv). Hind wing: length, 19.5-20 mm.; width, 4.6 mm.; similar to fore wings. Male genitalia: preëpiproct with irregular dorsal margin and inwardly curved rounded apex when seen from side; the median inner side of the preëpiproct furnished with two lobes, the dorsal one more or less elongate, with two or three short black bristles, coxopodites slightly produced upward, with emarginated apex; harpagones short, with rounded tips, the median outer margins slightly convex; aedeagus lobes on each side of the base of filum (spiral filament)rather short, with gently rounded outer margin and obtuse tips; proctiger narrowed towards apex, furnished with

a bundle of brown hairs; the lower process rather short, broad basally, pointed towards its apex.

Types (♂, ♀): Kuling, Kiangsi, Sept. 19, 1934 (Piel); in Heude Museum, Shanghai.

Distribution: same as type.

This species, having a light brown wing membrane, differs from the other described *Bittacus* by the peculiar shape of the preëpiproct, which has an irregular dorsal margin and an inwardly curved rounded apex when seen from the side. The slender and heavily marked wing also makes its recognition easy.

BIBLIOGRAPHY

CARPENTER, F. M.

1931. Revision of the Nearctic Mecoptera. Bull. Mus. Comp. Zool., **72**:205-277.

1938. Mecoptera from China, with descriptions of new species. Proc. Ent. Soc. Washington, **40**(9):267-281.

1940. A new genus of Mecoptera from Tasmania. Pap. and Proc. Roy. Soc. Tasmania, 1940:51-53.

1945. Panorpidae from China (Mecoptera). Psyche, **52**(1-2):70-78.

1948. Notes on Chinese Panorpidae (Mecoptera). Psyche, **55**:28-30.

CHENG, F. Y.

1949. New species of Mecoptera from Northwest China. Psyche, **56**:139-173.

ESBEN-PETERSEN, P.

1921. Mecoptera. Collections Zoologiques du Baron Edm. de Selys Longchamps. Catalogue systematique et descriptif. Bruxelles, 1921:1-172.

1927. New and little-known species of Mecoptera and Neuroptera in the Zoological Museum of Helsingfors. Notul. Ent., **7**:13-18.

1934. Two new species of *Panorpa* Linn. (Mecoptera). Vidensk. Medd. Dansk Naturh. Foren., **97**:211-213.

ISSIKI, S.

1927. New and rare species of Mecoptera from Corea, Formosa and Japan. Insecta Matsum., Sapporo, **2**:1-12.

1929. Descriptions of new species of the genus *Panorpa* from Japan and Formosa. Journ. Soc. Trop. Agric., **1**:182-191.

1929. Descriptions of new Mecoptera from the Japanese Empire. Trans. Nat. Hist. Soc., Formosa, **19**(102):260-314.

1931. Two new species of scorpion flies (order Mecoptera). Ann. Mag. Nat. Hist., (10)**7**:219-222.

1933. Morphological studies on the Panorpidae of Japan and adjoining countries and comparison with American and European forms. Jap. Journ. Zool., Tokyo, **4**:315-416.

Issiki, S. and F. Y. Cheng

1947. Formosan Mecoptera with descriptions of new species. Mem. Coll. Agric. Nat. Taiwan Univ., **1**(4):1-17.

Lieftinck, M. A.

1936. Studies in Oriental Mecoptera. I. The genus *Leptopanorpa* in Malaysia. Treubia, Buitenzorg, **15**:271-320.

McLachan, R.

1894. On two small collections of Neuroptera from Tachienlu, in the province of Szechwan, western China, on the frontier of Tibet. Ann. Mag. Nat. Hist., (6)**13**:421-436.

Miyake, T.

1908. A list of Panorpidae of Japan, with descriptions of ten new species. Bull. Coll. Agric. Tokyo Imp. Univ., **8**(1):1-12.

1913. Studies on the Mecoptera of Japan. Journ. Coll. Agric. Univ. Tokyo, **4**:265-400.

Navas, L.

1908. Neurópteros nuevos. Mem. Real. Acad. Cienc. Art, Barcelona, 1908:406-417.

1931. Decadas de insectos nuevos. Rev. Acad. Cienc. Madrid, **26**:75.

1934. Névroptères et insectes voisins. Notes d'Ent. Chin. Mus. Heude, **2**:95-99.

Okamoto, H.

1925. The Mecoptera of Korea. Bull. Agric. Expt. Sta. Gov. Chosen, Suigen Korea, **2**(1):1-8.

Tjeder, B.

1936. Schwedisch-chinesische wissenschaftliche Expedition nach den nordwestlichen Provinzen Chinas. 51. Mecoptera. Ark. för Zool., **27**(A):1-14.

1950. Mecopteren aus Fukien. Bonn Zool. Beitr., 1950(2-4):286-290.

Wu, C. P.

1937. Catalogus insectorum sinensium. Peiping, **3**:1263-1269.

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PLATES

PLATE 1

Fig. 1. *Panorpa tjederi* Carpenter, preëpiproct of ♂ type after B. Tjeder in K. J. Morton Collection, Edinburgh.

Fig. 2. *Panorpa diceras* McLachlan, preëpiproct of ♂ type after F. M. Carpenter in British Museum (Natural History).

Fig. 3. *Panorpa flavipennis* Carpenter, preëpiproct of ♂ holotype, in U. S. National Museum.

Fig. 4. *Panorpa kimminsi* Carpenter, preëpiproct of ♂ paratype in M. C. Z., Cambridge.

Fig. 5. *Panorpa centralis* Tjeder, preëpiproct of ♂ holotype in Stockholm Museum.

Fig. 6. *Panorpa tjederi* Carpenter, genital bulb of ♂ type after B. Tjeder in K. J. Morton Collection, Edinburgh.

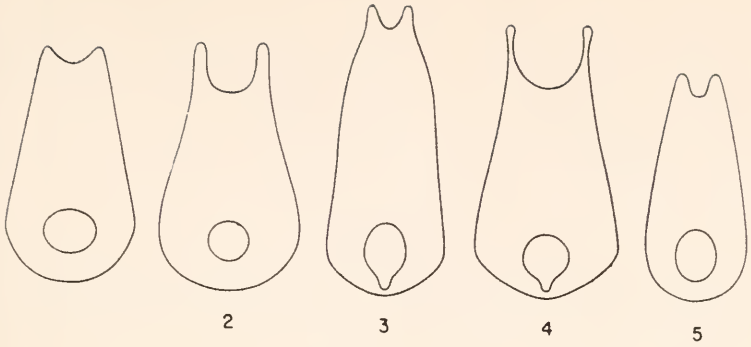
Fig. 7. *Panorpa diceras* McLachlan, genital bulb of ♂ type after F. M. Carpenter in British Museum (Natural History).

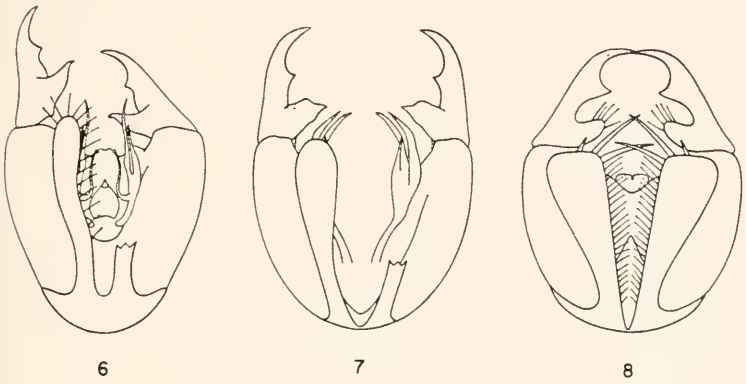
Fig. 8. *Panorpa stotzneri* Esben-Petersen, genital bulb of ♂ type after Esben-Petersen in Staatl. Museum für Tier- und Völkerkunde, Dresden.

Fig. 9. *Panorpa kimminsi* Carpenter, genital bulb of ♂ paratype in M. C. Z., Cambridge.

Fig. 10. *Panorpa centralis* Tjeder, genital bulb of ♂ holotype in Stockholm Museum.

Fig. 11. *Panorpa flavipennis* Carpenter, genital bulb of ♂ holotype, in U. S. National Museum.





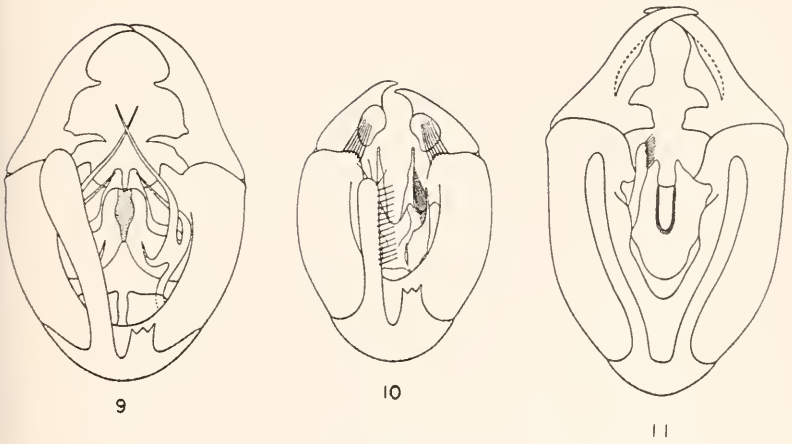


PLATE 1

PLATE 2

Fig. 12. *Panorpa tjederi* Carpenter, 9th abdominal segment of ♀ type (lateral view) after B. Tjeder in K. J. Morton Collection, Edinburgh.

Fig. 13. *Panorpa flavipennis* Carpenter, 6th abdominal segment (lateral view) of ♂ holotype, in U. S. National Museum.

Fig. 14. *Panorpa tjederi* Carpenter, subgenital plate of ♀ type after B. Tjeder in K. J. Morton Collection, Edinburg.

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Fig. 16. *Panorpa kimminsi* Carpenter, subgenital plate of ♀ paratype in M. C. Z., Cambridge.

Fig. 17. *Panorpa tjederi* Carpenter, internal skeleton of ♀ type after B. Tjeder in K. J. Morton Collection, Edinburgh.

Fig. 18. *Panorpa stotzneri* Esben-Petersen, internal skeleton of ♀ type after B. Tjeder in Esben-Petersen Collection, Silkeborg.

Fig. 19. *Panorpa kimminsi* Carpenter, internal skeleton of ♀ paratype in M. C. Z., Cambridge.

Fig. 20. *Panorpa centralis* Tjeder, internal skeleton of ♀ allotype in Stockholm Museum.

Fig. 21. *Panorpa centralis* Tjeder, subgenital plate of ♀ allotype in Stockholm Museum.

Fig. 22. *Panorpa flavipennis* Carpenter, subgenital plate of ♀ allotype, in U. S. National Museum.

Fig. 23. *Panorpa flavipennis* Carpenter, internal skeleton of ♀ allotype, in U. S. National Museum.

Fig. 24. *Panorpa emarginata* Cheng, internal skeleton of ♀ allotype in Cheng Collection, Taipeh.

Fig. 25. *Panorpa emarginata* Cheng, subgenital plate of ♀ allotype in Cheng Collection, Taipeh.

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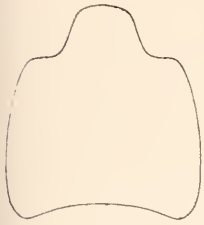

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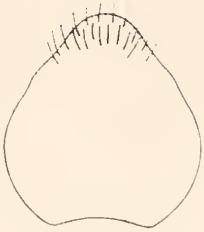

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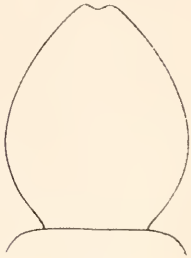

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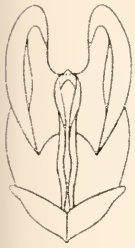

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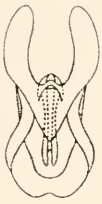

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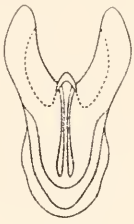

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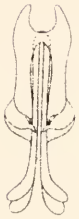

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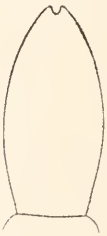

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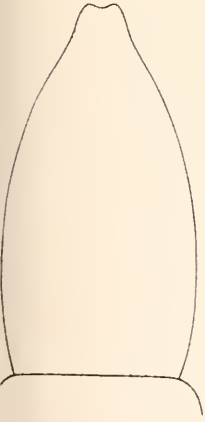

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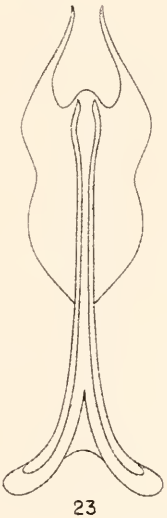

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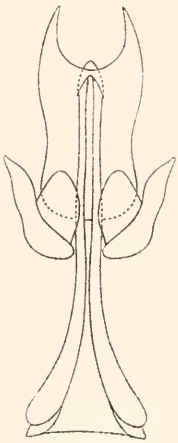

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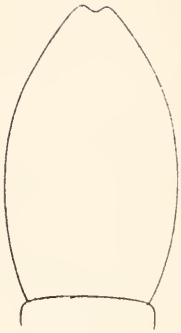

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PLATE 2

PLATE 3

Fig. 26. *Panorpa typicoides* Cheng, preëpiproct of ♂ holotype in M. C. Z., Cambridge.

Fig. 27. *Panorpa emarginata* Cheng, preëpiproct of ♂ holotype in M. C. Z., Cambridge.

Fig. 28. *Panorpa obtusa* Cheng, preëpiproct of ♂ holotype in Cheng Collection, Taipeh.

Fig. 29. *Panorpa fructa* Cheng, preëpiproct of ♂ holotype in Cheng Collection, Taipeh.

Fig. 30. *Panorpa stigmalis* Navas, preëpiproct of ♂ holotype after Esben-Petersen in Muséum National d'Histoire Naturelle, Paris.

Fig. 31. *Panorpa emarginata* Cheng, genital bulb of ♂ holotype in M. C. Z., Cambridge.

Fig. 32. *Panorpa emarginata* Cheng, genital bulb of ♂ holotype, showing aedeagus, in M. C. Z., Cambridge.

Fig. 33. *Panorpa stigmalis* Navas, genital bulb of ♂ holotype after Esben-Petersen in Muséum National d'Histoire Naturelle, Paris.

Fig. 34. *Panorpa obtusa* Cheng, genital bulb of ♂ holotype in Cheng Collection, Taipeh.

Fig. 35. *Panorpa fructa* Cheng, genital bulb of ♂ holotype in Cheng Collection, Taipeh.

Fig. 36. *Panorpa typicoides* Cheng, genital bulb of ♂ holotype in M. C. Z., Cambridge.

Fig. 37. *Panorpa obtusa* Cheng, genital bulb of ♂ holotype, showing aedeagus, in Cheng Collection, Taipeh.

Fig. 38. *Panorpa fructa* Cheng, genital bulb of ♂ holotype, showing aedeagus, in Cheng Collection, Taipeh.

Fig. 39. *Panorpa typicoides* Cheng, genital bulb of ♂ holotype, showing aedeagus, in M. C. Z., Cambridge.

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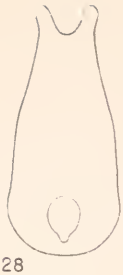
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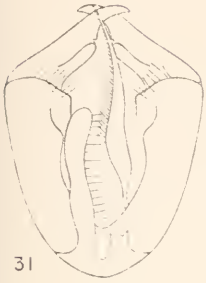
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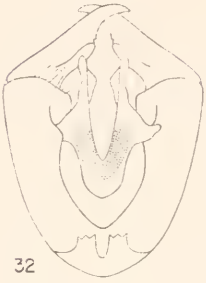
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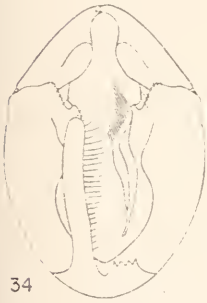
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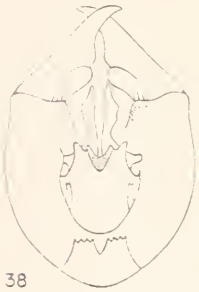
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PLATE 3

PLATE 4

Fig. 40. *Panorpa trifasciata* n. sp., preëpiproct of ♂ holotype in Museum of Foochow University, Foochow.

Fig. 41. *Panorpa cladocerca* Navas, preëpiproct of ♂ paratype in Heude Museum, Shanghai.

Fig. 42. *Panorpa difficilis* Carpenter, preëpiproct of ♂ holotype in U. S. National Museum.

Fig. 43. *Panorpa waongkehzengi* Navas, preëpiproct of ♂ paratype, in Heude Museum, Shanghai.

Fig. 44. *Panorpa obliqua* Carpenter, preëpiproct of ♂ holotype in M. C. Z., Cambridge.

Fig. 45. *Panorpa obliqua* Carpenter, genital bulb of ♂ holotype in M. C. Z., Cambridge.

Fig. 46. *Panorpa difficilis* Carpenter, genital bulb of ♂ holotype in U. S. National Museum.

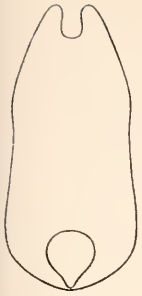
Fig. 47. *Panorpa waongkehzengi* Navas, genital bulb of ♂ paratype, showing aedeagus, in Heude Museum, Shanghai.

Fig. 48. *Panorpa waongkehzengi* Navas, genital bulb of ♂ paratype, in Heude Museum, Shanghai.

Fig. 49. *Panorpa trifasciata* n. sp., genital bulb of ♂ holotype in Museum of National Foochow University, Foochow.

Fig. 50. *Panorpa trifasciata* n. sp., genital bulb of ♂ holotype, showing aedeagus, in Museum of National Foochow University, Foochow.

Fig. 51. *Panorpa cladocerca* Navas, genital bulb of ♂ paratype in Heude Museum, Shanghai.



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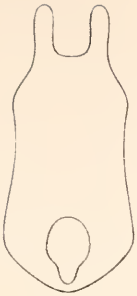

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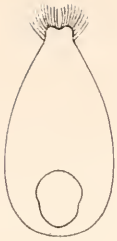

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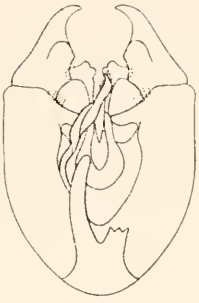

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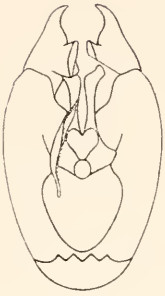

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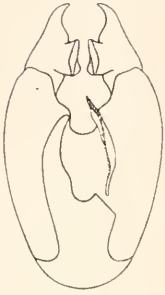

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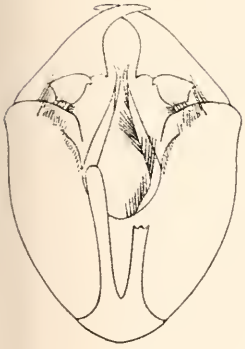

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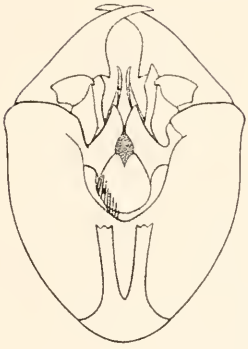

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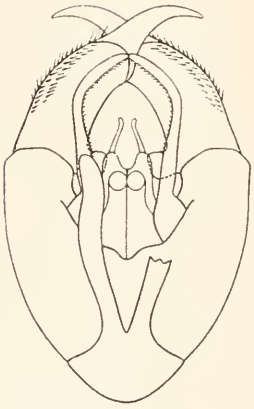

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PLATE 4

PLATE 5

Fig. 52. *Panorpa curva* Carpenter, genital bulb of ♂ holotype in U. S. National Museum.

Fig. 53. *Panorpa curva* Carpenter, preëpiproct of ♂ holotype in U. S. National Museum.

Fig. 54. *Panorpa fukiensis* Tjeder, preëpiproct of ♂ holotype in Museum A. Koenig, Bonn.

Fig. 55. *Panorpa aurea* n. sp., preëpiproct of ♂ holotype in Maa Collection, Taipeh.

Fig. 56. *Panorpa cheni* n. sp., preëpiproct of ♂ holotype in Museum of Institute of Zoology, Academia Sinica, Shanghai.

Fig. 57. *Panorpa davidi* Navas, genital bulb of ♂ holotype after F. M. Carpenter in Muséum National d'Histoire Naturelle, Paris.

Fig. 58. *Panorpa fukiensis* Tjeder, genital bulb of ♂ holotype after B. Tjeder in Museum A. Koenig, Bonn.

Fig. 59. *Panorpa flavicorporis* n. sp., genital bulb of ♂ holotype in Museum of National Foochow University, Foochow.

Fig. 60. *Panorpa flavicorporis* n. sp., genital bulb of ♂ holotype, showing aedeagus, in Museum of National Foochow University, Foochow.

Fig. 61. *Panorpa aurea* n. sp., genital bulb of ♂ holotype, showing aedeagus, in Maa Collection, Taipeh.

Fig. 62. *Panorpa aurea* n. sp., genital bulb of ♂ holotype, in Maa Collection, Taipeh.

Fig. 63. *Panorpa coomani* n. sp., genital bulb of ♂ holotype in Heude Museum, Shanghai.

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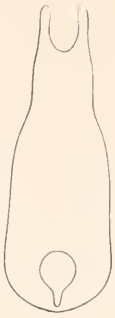

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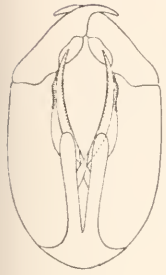

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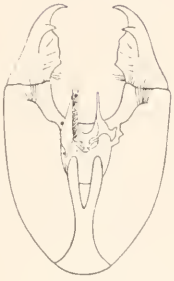

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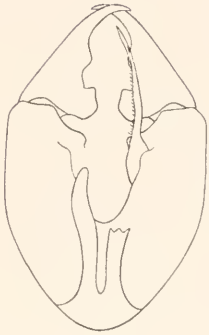

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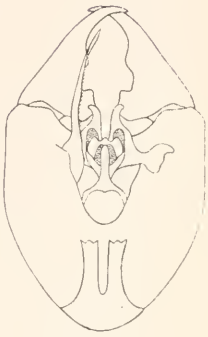

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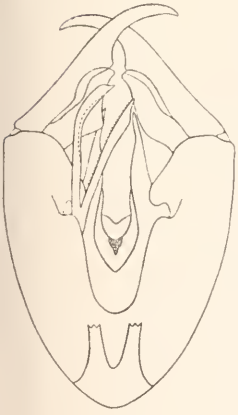

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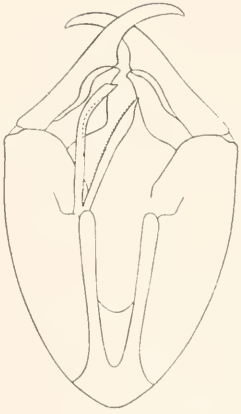

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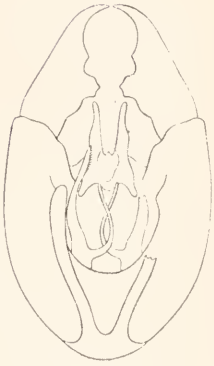

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PLATE 5

PLATE 6

Fig. 64. *Panorpa trifasciata* n. sp., subgenital plate of ♀ allotype in Maa Collection, Taipeh.

Fig. 65. *Panorpa trifasciata* n. sp., internal skeleton of ♀ allotype in Maa Collection, Taipeh.

Fig. 66. *Panorpa typicoides* Cheng, subgenital plate of ♀ allotype in Cheng Collection, Taipeh.

Fig. 67. *Panorpa typicoides* Cheng, internal skeleton of ♀ allotype in Cheng Collection, Taipeh.

Fig. 68. *Panorpa cladocerca* Navas, internal skeleton of ♀ paratype in Heude Museum, Shanghai.

Fig. 69. *Panorpa flavicorporis* n. sp., internal skeleton of ♀ allotype in Maa Collection, Taipeh.

Fig. 70. *Panorpa fukiensis* Tjeder, subgenital plate of ♀ allotype after B. Tjeder in Museum A. Koenig, Bonn.

Fig. 71. *Panorpa fukiensis* Tjeder, internal skeleton of ♀ allotype after B. Tjeder in Museum A. Koenig, Bonn.

Fig. 72. *Panorpa waongkehzengi* Navas, subgenital plate of ♀ paratype, in Heude Museum, Shanghai.

Fig. 73. *Panorpa waongkehzengi* Navas, internal skeleton of ♀ paratype, in Heude Museum, Shanghai.

Fig. 74. *Panorpa cladocerca* Navas, subgenital plate of ♀ paratype in Heude Museum, Shanghai.

Fig. 75. *Panorpa flavicorporis* n. sp., subgenital plate of ♀ allotype in Maa Collection, Taipeh.

Fig. 76. *Panorpa aurea* n. sp., subgenital plate of ♀ allotype in Museum of National Foochow University, Foochow.

Fig. 77. *Panorpa aurea* n. sp., internal skeleton of ♀ allotype in Museum of National Foochow University, Foochow.

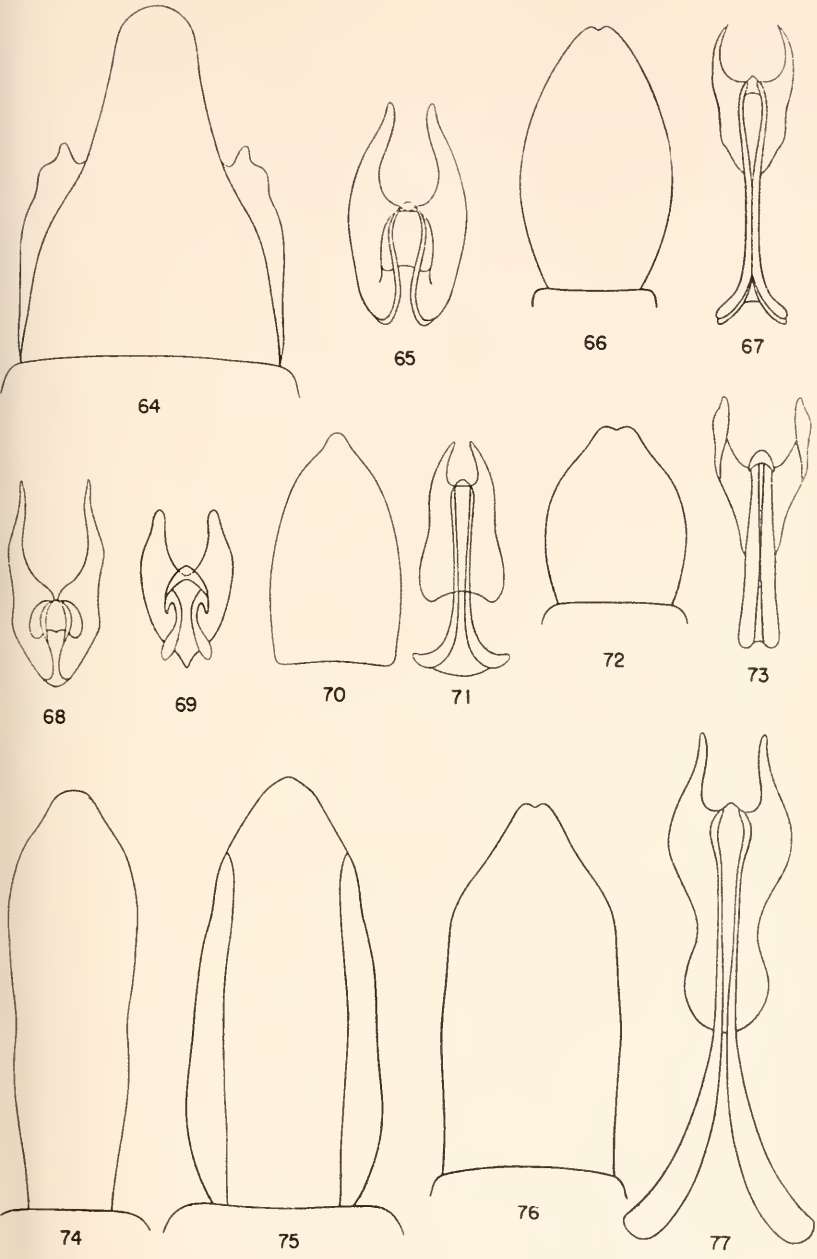


PLATE 6

PLATE 7

Fig. 78. *Panorpa tincta* Navas, 6th to 8th abdominal segments of ♂ holotype after Navas in Hamburg Museum.

Fig. 79. *Panorpa coomani* n. sp., preëpiproct of ♂ holotype in Heude Museum, Shanghai.

Fig. 80. *Panorpa flavicorporis* n. sp., preëpiproct of ♂ holotype, in Museum of National Foochow University, Foochow.

Fig. 81. *Panorpa sexspinosa* Cheng, preëpiproct of ♂ holotype in Cheng Collection, Taipeh.

Fig. 82. *Panorpa baohwashana* n. sp., genital bulb of ♂ holotype, showing aedeagus, in Museum of Institute of Zoology, Academia Sinica, Shanghai.

Fig. 83. *Panorpa baohwashana* n. sp., genital bulb of ♂ holotype in Museum of Institute of Zoology, Academia Sinica, Shanghai.

Fig. 84. *Panorpa baohwashana* n. sp., preëpiproct of ♂ holotype in Museum of Institute of Zoology, Academia Sinica, Shanghai.

Fig. 85. *Panorpa japonica* Thunberg, preëpiproct of ♂ identified specimen in Cheng Collection, Taipeh.

Fig. 86. *Panorpa cheni* n. sp., genital bulb of ♂ holotype in Museum of Institute of Zoology, Academia Sinica, Shanghai.

Fig. 87. *Panorpa sexspinosa* Cheng, genital bulb of ♂ holotype in Cheng Collection, Taipeh.

Fig. 88. *Panorpa cheni* n. sp., genital bulb of ♂ holotype, showing aedeagus, in Museum of Institute of Zoology, Academia Sinica, Shanghai.

Fig. 89. *Panorpa sexspinosa* Cheng, genital bulb of ♂ holotype, showing aedeagus, in Cheng Collection, Taipeh.

Fig. 90. *Panorpa japonica* Thunberg, genital bulb of ♂ identified specimen in Cheng Collection, Taipeh.

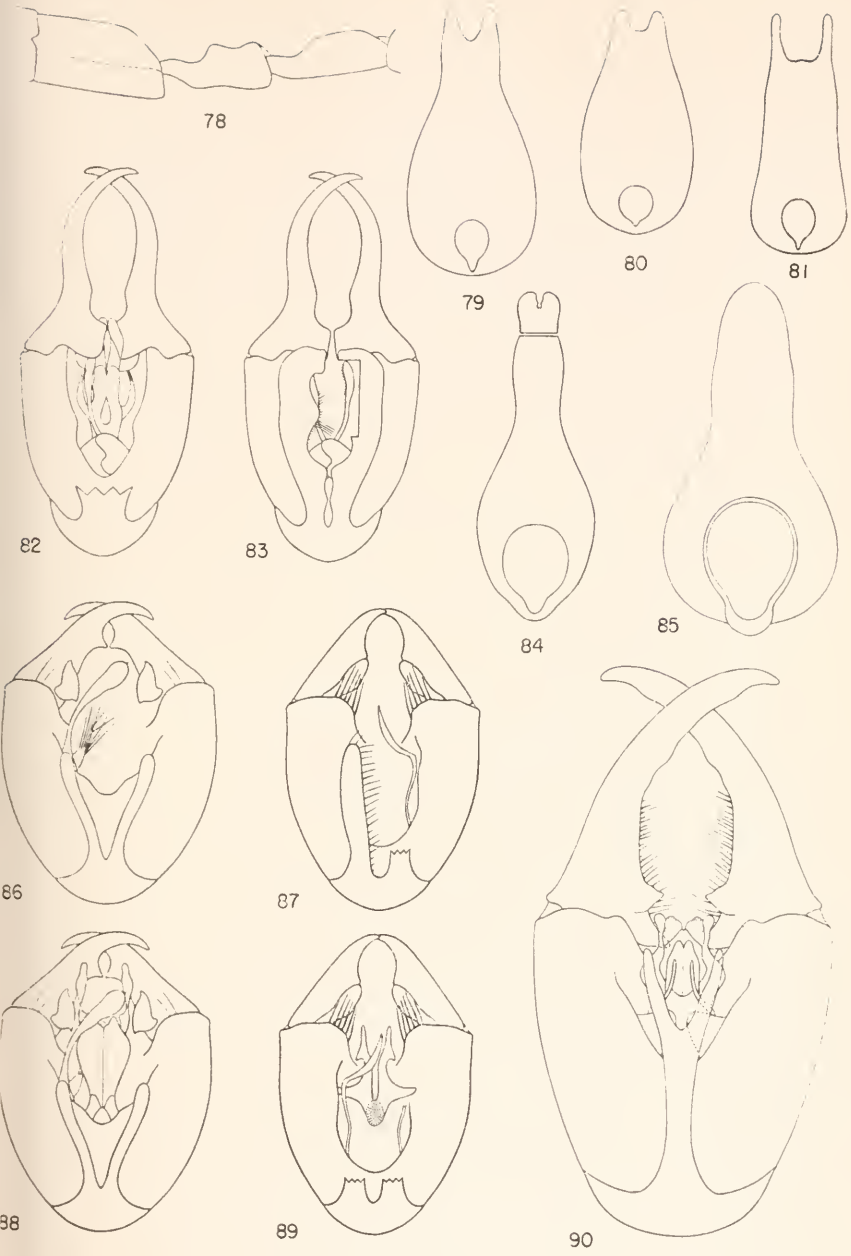


PLATE 7

PLATE 8

Fig. 91. *Panorpa tetrazonia* Navas, genital bulb of ♂ identified specimen in M. C. Z., Cambridge.

Fig. 92. *Panorpa tetrazonia* Navas, preëpiproct of ♂ identified specimen in M. C. Z., Cambridge.

Fig. 93. *Panorpa tetrazonia* Navas, subgenital plate of ♀ identified specimen in M. C. Z., Cambridge.

Fig. 94. *Panorpa tetrazonia* Navas, internal skeleton of ♀ identified specimen in M. C. Z., Cambridge.

Fig. 95. *Panorpa cheni* n. sp., subgenital plate of ♀ allotype in Museum of Institute of Zoology, Academia Sinica, Shanghai.

Fig. 96. *Panorpa cheni* n. sp., internal skeleton of ♀ allotype in Museum of Institute of Zoology, Academia Sinica, Shanghai.

Fig. 97. *Panorpa obliqua* Carpenter, subgenital plate of ♀ allotype in M. C. Z., Cambridge.

Fig. 98. *Panorpa obliqua* Carpenter, internal skeleton of ♀ allotype in M. C. Z., Cambridge.

Fig. 99. *Panorpa implicata* n. sp., subgenital plate of ♀ holotype in Museum of National Foochow University, Foochow.

Fig. 100. *Panorpa japonica* Thunberg, internal skeleton of ♀ identified specimen in Cheng Collection, Taipeh.

Fig. 101. *Panorpa baohwashana* n. sp., subgenital plate of ♀ allotype in Museum of Institute of Zoology, Academia Sinica, Shanghai.

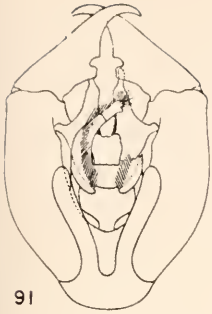
Fig. 102. *Panorpa bonis* Cheng, subgenital plate of ♀ holotype after B. Tjeder in Stockholm Museum.

Fig. 103. *Panorpa implicata* n. sp., internal skeleton of ♀ holotype in Museum of National Foochow University, Foochow.

Fig. 104. *Panorpa japonica* Thunberg, subgenital plate of ♀ identified specimen in Cheng Collection, Taipeh.

Fig. 105. *Panorpa baohwashana* n. sp., internal skeleton of ♀ allotype in Museum of Institute of Zoology, Academia Sinica, Shanghai.

Fig. 106. *Panorpa bonis* Cheng, internal skeleton of ♀ holotype after B. Tjeder in Stockholm Museum.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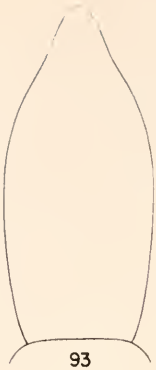
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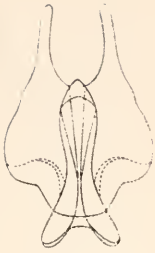
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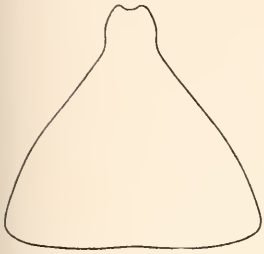
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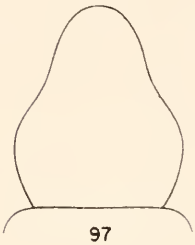
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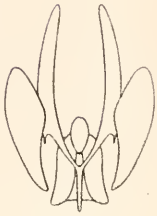
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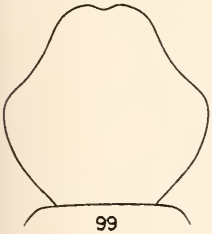
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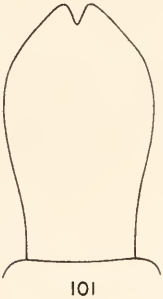
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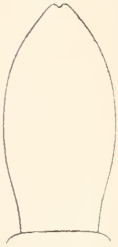
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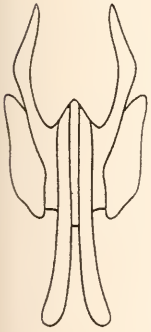
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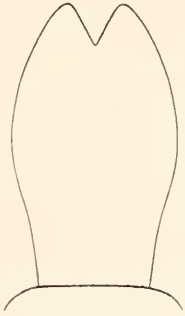
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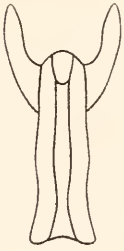
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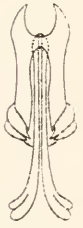
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PLATE 8

PLATE 9

Fig. 107. *Panorpa lutea* Carpenter, subgenital plate of ♀ holotype in M. C. Z., Cambridge.

Fig. 108. *Panorpa grahamana* n. sp., subgenital plate of ♀ holotype in M. C. Z., Cambridge.

Fig. 109. *Panorpa statura* Cheng, subgenital plate of ♀ holotype in Cheng Collection, Taipeh.

Fig. 110. *Panorpa statura* Cheng, internal skeleton of ♀ holotype in Cheng Collection, Taipeh.

Fig. 111. *Panorpa pieli* n. sp., subgenital plate of ♀ holotype in Heude Museum, Shanghai.

Fig. 112. *Panorpa lutea* Carpenter, internal skeleton of ♀ holotype in M. C. Z., Cambridge.

Fig. 113. *Panorpa semifasciata* Cheng, subgenital plate of ♀ holotype in Cheng Collection, Taipeh.

Fig. 114. *Panorpa semifasciata* Cheng, internal skeleton of ♀ holotype in Cheng Collection, Taipeh.

Fig. 115. *Panorpa grahamana* n. sp., internal skeleton of ♀ holotype in M. C. Z., Cambridge.

Fig. 116. *Panorpa carpenteri* n. sp., internal skeleton of ♀ holotype in M. C. Z., Cambridge.

Fig. 117. *Panorpa pieli* n. sp., internal skeleton of ♀ holotype in Heude Museum, Shanghai.

Fig. 118. *Panorpa pusilla* Cheng, internal skeleton of ♀ holotype in M. C. Z., Cambridge.

Fig. 119. *Panorpa pusilla* Cheng, subgenital plate of ♀ holotype in M. C. Z., Cambridge.

Fig. 120. *Panorpa klapperichi* Tjeder, internal skeleton (ventral view) of ♀ holotype after B. Tjeder in Museum A. Koenig, Bonn.

Fig. 121. *Panorpa klapperichi* Tjeder, internal skeleton (lateral view) of ♀ holotype after B. Tjeder in Museum A. Koenig, Bonn.

Fig. 122. *Panorpa semifasciata* Cheng, ventral view of last few abdominal segments of ♀ holotype in Cheng Collection, Taipeh.

Fig. 123. *Panorpa sexspinosa* Cheng, subgenital plate of ♀ allotype in M. C. Z., Cambridge.

Fig. 124. *Panorpa sexspinosa* Cheng, internal skeleton of ♀ allotype in M. C. Z., Cambridge.

Fig. 125. *Panorpa leei* Cheng, subgenital plate of ♀ holotype in M. C. Z., Cambridge.

Fig. 126. *Panorpa klapperichi* Tjeder, subgenital plate of ♀ holotype after B. Tjeder in Museum A. Koenig, Bonn.

Fig. 127. *Panorpa leei* Cheng, internal skeleton of ♀ holotype in M. C. Z., Cambridge.

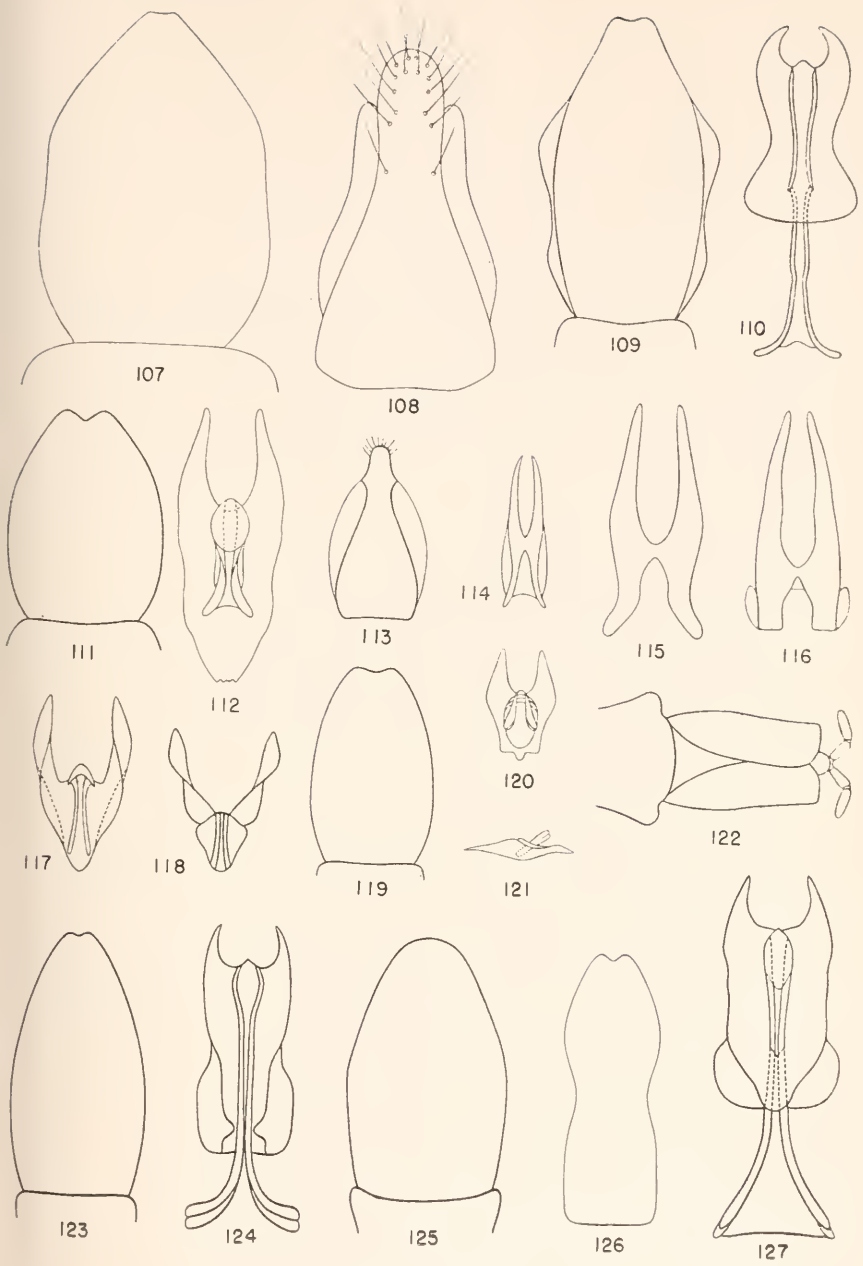
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PLATE 9

PLATE 10

Fig. 128. *Neopanorpa caveata* n. sp., median process of the 3rd abdominal tergite of ♂ holotype in Museum of National Foochow University, Foochow.

Fig. 129. *Neopanorpa caveata* n. sp., preëpiproct of ♂ holotype in Museum of National Foochow University, Foochow.

Fig. 130. *Neopanorpa tienmushana* n. sp., preëpiproct of ♂ holotype in Museum of Institute of Zoology, Academia Sinica, Shanghai.

Fig. 131. *Neopanorpa claripennis* Carpenter, preëpiproct of ♂ paratype in M. C. Z., Cambridge.

Fig. 132. *Ncopanorpa claripennis* Carpenter, median process of the 3rd abdominal tergite of ♂ paratype in M. C. Z., Cambridge.

Fig. 133. *Neopanorpa caveata* n. sp., genital bulb of ♂ holotype in Museum of National Foochow University, Foochow.

Fig. 134. *Neopanorpa tienmushana* n. sp., genital bulb of ♂ holotype in Museum of Institute of Zoology, Academia Sinica, Shanghai.

Fig. 135. *Neopanorpa huangshana* n. sp., genital bulb of ♂ holotype in Museum of Institute of Zoology, Academia Sinica, Shanghai.

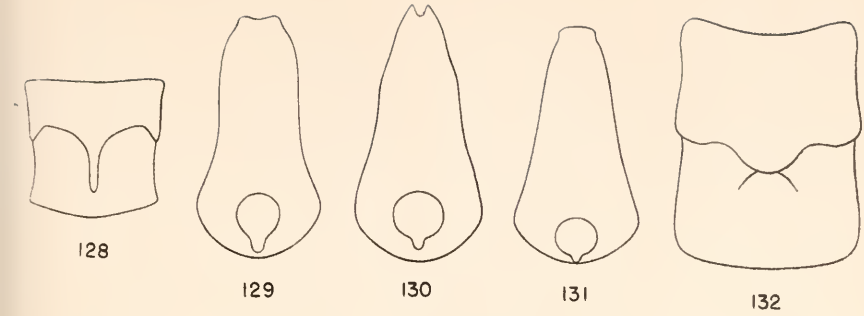
Fig. 136. *Neopanorpa claripennis* Carpenter, genital bulb of ♂ paratype in M. C. Z., Cambridge.

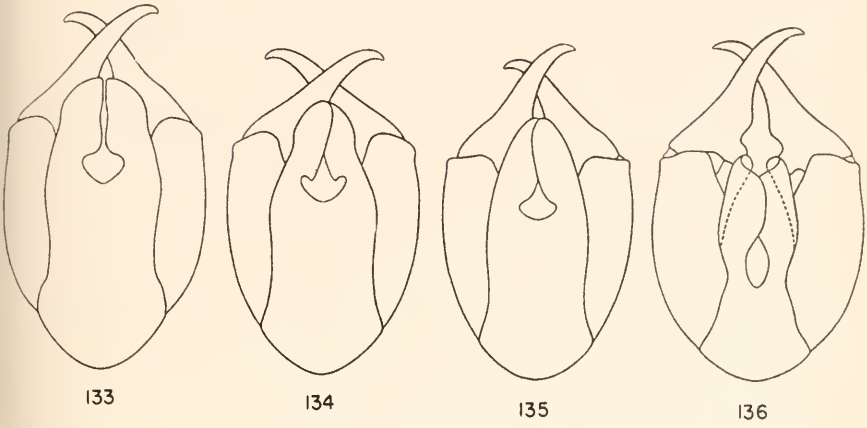
Fig. 137. *Neopanorpa caveata* n. sp., genital bulb of ♂ holotype, showing aedeagus, in Museum of National Foochow University, Foochow.

Fig. 138. *Neopanorpa tienmushana* n. sp., genital bulb of ♂ holotype, showing aedeagus, in Museum of Institute of Zoology, Academia Sinica, Shanghai.

Fig. 139. *Neopanorpa huangshana* n. sp., genital bulb of ♂ holotype, showing aedeagus, in Museum of Institute of Zoology, Academia Sinica, Shanghai.

Fig. 140. *Neopanorpa claripennis* Carpenter, genital bulb of ♂ paratype, showing aedeagus, in M. C. Z., Cambridge.





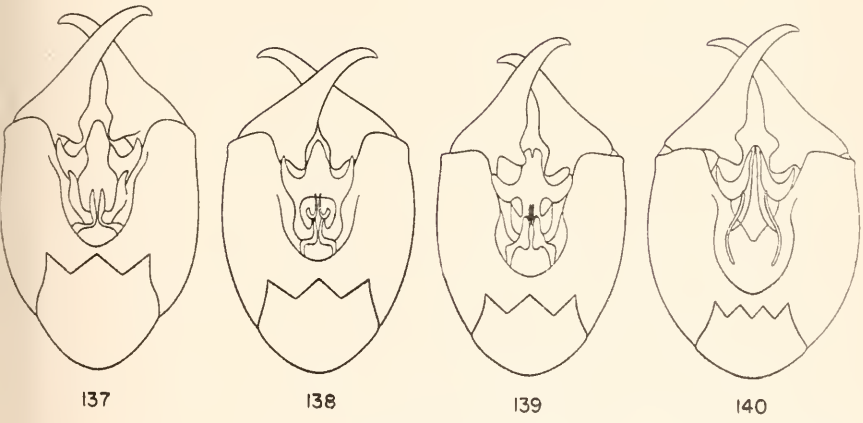


PLATE 10

PLATE 11

Fig. 141. *Neopanorpa mutabilis* n. sp., genital bulb of ♂ holotype in Museum of National Foochow University, Foochow.

Fig. 142. *Neopanorpa mutabilis* n. sp., genital bulb of ♂ holotype, showing aedeagus, in Museum of National Foochow University, Foochow.

Fig. 143. *Neopanorpa maai* n. sp., genital bulb of ♂ holotype in Museum of National Foochow University, Foochow.

Fig. 144. *Neopanorpa maai* n. sp., genital bulb of ♂ holotype, showing aedeagus, in Museum of National Foochow University, Foochow.

Fig. 145. *Neopanorpa validipennis* Cheng, genital bulb of ♂ holotype in Cheng Collection, Taipeh.

Fig. 146. *Neopanorpa validipennis* Cheng, genital bulb of ♂ holotype, showing aedeagus, in Cheng Collection, Taipeh.

Fig. 147. *Neopanorpa translucida* n. sp., genital bulb of ♂ holotype, showing aedeagus, in Museum of National Foochow University, Foochow.

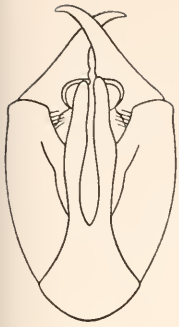
Fig. 148. *Neopanorpa translucida* n. sp., genital bulb of ♂ holotype in Museum of National Foochow University, Foochow.

Fig. 149. *Neopanorpa ovata* n. sp., genital bulb of ♂ holotype in Maa Collection, Taipeh.

Fig. 150. *Neopanorpa ovata* n. sp., genital bulb of ♂ holotype, showing aedeagus, in Maa Collection, Taipeh.

Fig. 151. *Neopanorpa pielina* Navas, genital bulb of ♂ paratype in Heude Museum, Shanghai.

Fig. 152. *Neopanorpa pielina* Navas, genital bulb of ♂ paratype, showing aedeagus, in Heude Museum, Shanghai.



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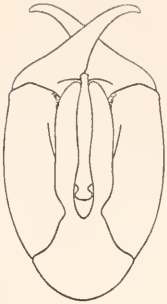

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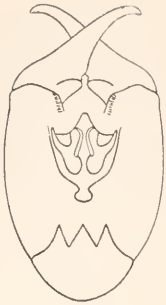

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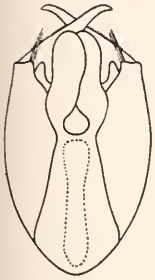

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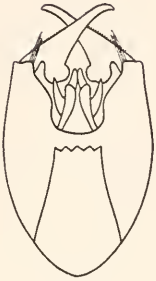

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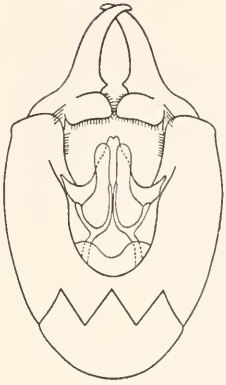

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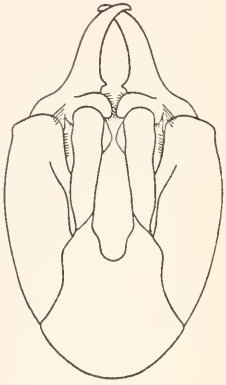

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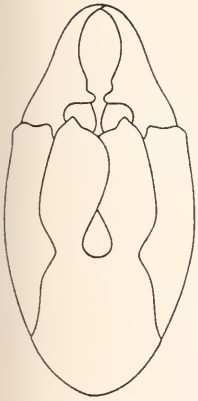

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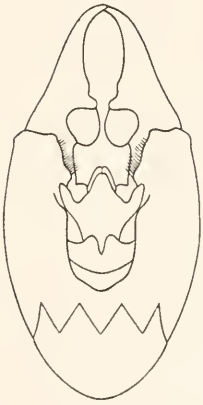

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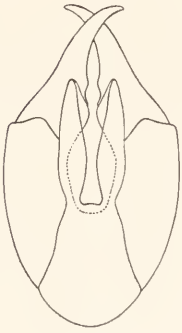

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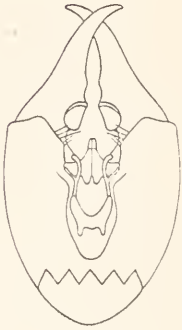

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PLATE 11

PLATE 12

Fig. 153. *Neopanorpa choui* Cheng, subgenital plate of ♀ allotype in Cheng Collection, Taipeh.

Fig. 154. *Neopanorpa choui* Cheng, internal skeleton of ♀ allotype in Cheng Collection, Taipeh.

Fig. 155. *Neopanorpa choui* Cheng, median process of 3rd abdominal tergite (lateral view) of ♂ holotype in Cheng Collection, Taipeh.

Fig. 156. *Neopanorpa hcii* Cheng, preëpiproct of ♂ holotype in Cheng Collection, Taipeh.

Fig. 158. *Neopanorpa taoi* Cheng, genital bulb of ♂ holotype, showing aedeagus in Cheng Collection, Taipeh.

Fig. 159. *Neopanorpa taoi* Cheng, preëpiproct of ♂ holotype in Cheng Collection, Taipeh.

Fig. 160. *Neopanorpa taoi* Cheng, median process of 3rd abdominal tergite (lateral view) of ♂ holotype in Cheng Collection, Taipeh.

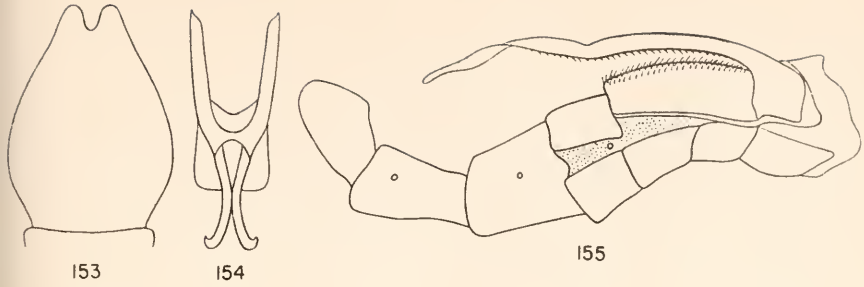
Fig. 161. *Neopanorpa choui* Cheng, preëpiproct of ♂ holotype in Cheng Collection, Taipeh.

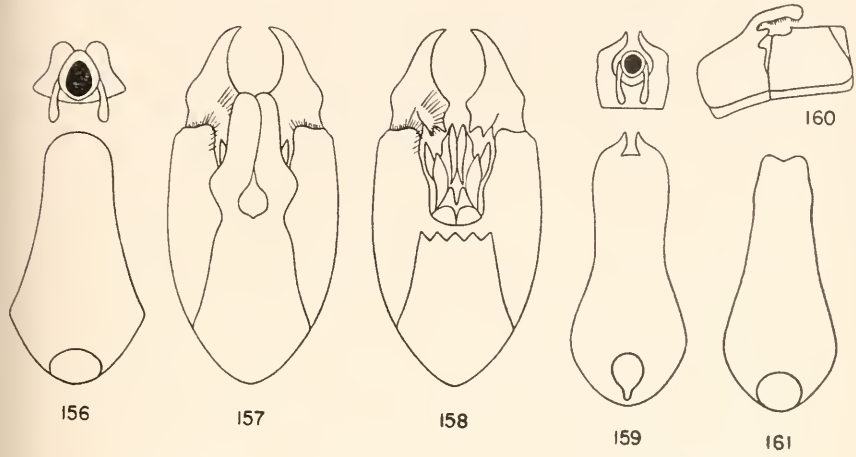
Fig. 162. *Neopanorpa hcii* Cheng, genital bulb of ♂ holotype in Cheng Collection, Taipeh.

Fig. 163. *Neopanorpa hcii* Cheng, genital bulb of ♂ holotype, showing aedeagus, in Cheng Collection, Taipeh.

Fig. 164. *Neopanorpa choui* Cheng, genital bulb of ♂ holotype in Cheng Collection, Taipeh.

Fig. 165. *Neopanorpa choui* Cheng, genital bulb of ♂ holotype, showing aedeagus, in Cheng Collection, Taipeh.





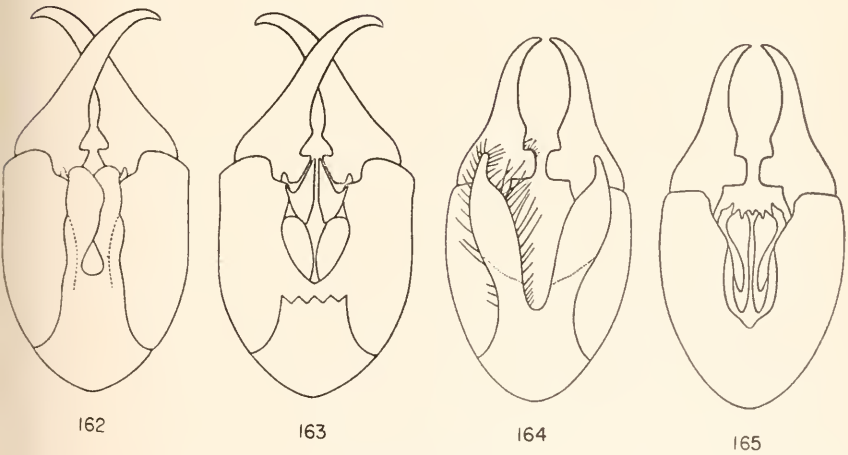


PLATE 12

PLATE 13

Fig. 166. *Neopanorpa huangshana* n. sp., subgenital plate of ♀ allotype in Museum of Institute of Zoology, Academia Sinica, Shanghai.

Fig. 167. *Neopanorpa tienmushana* n. sp., subgenital plate of ♀ allotype in Museum of Institute of Zoology, Academia Sinica, Shanghai.

Fig. 168. *Neopanorpa claripennis* Carpenter, subgenital plate of ♀ paratype in M. C. Z., Cambridge.

Fig. 169. *Neopanorpa chelata* Carpenter, subgenital plate of ♀ paratype in M. C. Z., Cambridge.

Fig. 170. *Neopanorpa huangshana* n. sp., internal skeleton of ♀ allotype in Museum of Institute of Zoology, Academia Sinica, Shanghai.

Fig. 171 *Neopanorpa tienmushana* n. sp., internal skeleton of ♀ allotype in Museum of Institute of Zoology, Academia Sinica, Shanghai.

Fig. 172. *Neopanorpa claripennis* Carpenter, internal skeleton of ♀ paratype in M. C. Z., Cambridge.

Fig. 173. *Neopanorpa chelata* Carpenter, internal skeleton of ♀ paratype in M. C. Z., Cambridge.

Fig. 174. *Neopanorpa chaoi* n. sp., subgenital plate of ♀ holotype in Museum of National Foochow University, Foochow.

Fig. 175. *Neopanorpa cantonensis* n. sp., subgenital plate of ♀ holotype in Heude Museum, Shanghai.

Fig. 176. *Neopanorpa carpenteri* n. sp., subgenital plate of ♀ holotype in M. C. Z., Cambridge.

Fig. 177. *Neopanorpa banksi* Carpenter, subgenital plate of ♀ holotype in U. S. National Museum.

Fig. 178. *Neopanorpa chaoi* n. sp., internal skeleton of ♀ holotype in Museum of National Foochow University, Foochow.

Fig. 179. *Neopanorpa cantonensis* n. sp., internal skeleton of ♀ holotype in Heude Museum, Shanghai.

Fig. 180. *Neopanorpa carpenteri* n. sp., internal skeleton of ♀ holotype in M. C. Z., Cambridge.

Fig. 181. *Neopanorpa banksi* Carpenter, internal skeleton of ♀ holotype in U. S. National Museum.

Fig. 182. *Neopanorpa pulchra* Carpenter, subgenital plate of ♀ holotype in M. C. Z., Cambridge.

Fig. 183. *Neopanorpa pulchra* Carpenter, internal skeleton of ♀ holotype in M. C. Z., Cambridge.

Fig. 184. *Neopanorpa parva* Carpenter, subgenital plate of ♀ holotype in M. C. Z., Cambridge.

Fig. 185. *Neopanorpa parva* Carpenter, internal skeleton of ♀ holotype in M. C. Z., Cambridge.

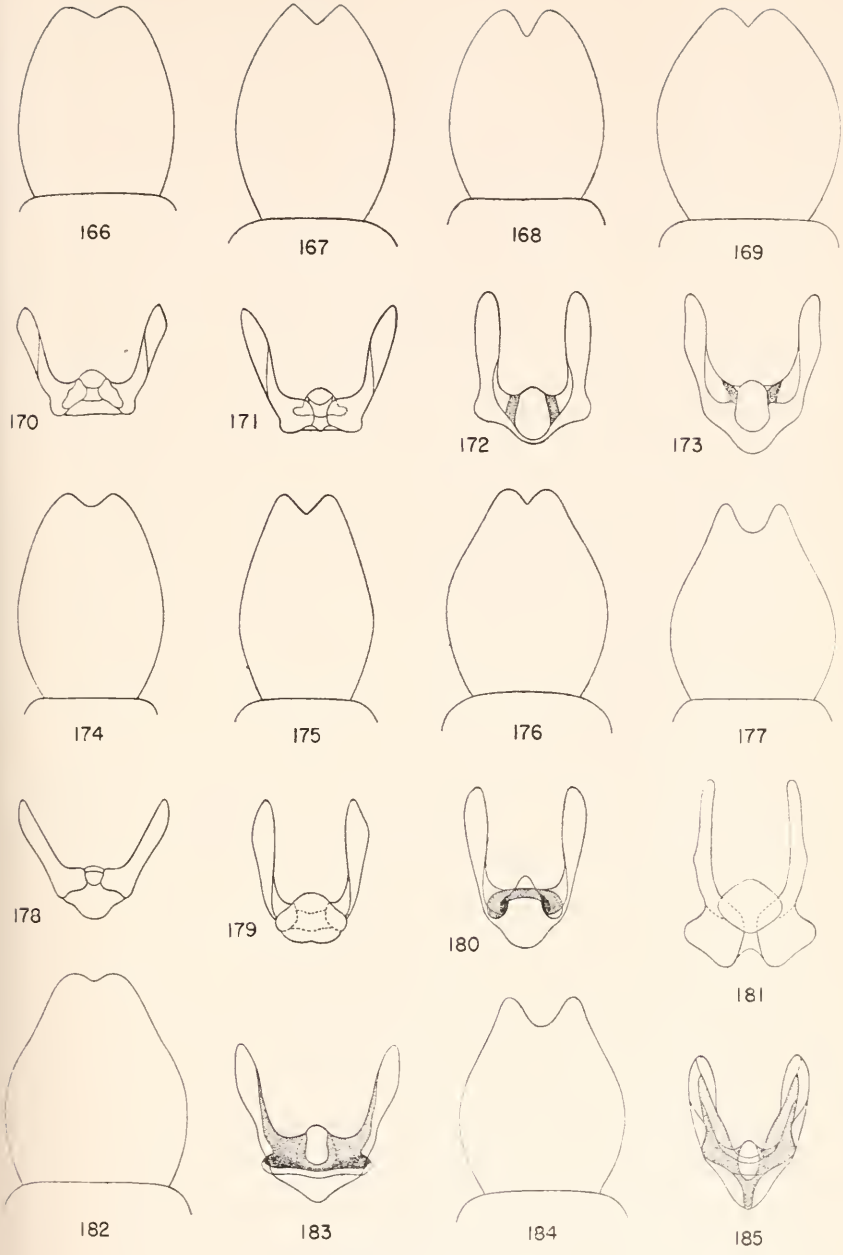

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PLATE 13

PLATE 14

Fig. 186. *Neopanorpa chelata* Carpenter, preëpiproct of ♂ paratype in M. C. Z., Cambridge.

Fig. 187. *Neopanorpa ovata* n. sp., preëpiproct of ♂ holotype in Maa Collection, Taipeh.

Fig. 188. *Neopanorpa brisi* Navas, last few abdominal segments of ♂ holotype by Navas in Navas Collection.

Fig. 189. *Neopanorpa nigritis* Carpenter, preëpiproct (dorsal view) of ♂ paratype in M. C. Z., Cambridge.

Fig. 190. *Neopanorpa nigritis* Carpenter, preëpiproct (lateral view) of ♂ paratype in M. C. Z., Cambridge.

Fig. 191. *Neopanorpa nigritis* Carpenter, genital bulb of ♂ paratype in M. C. Z., Cambridge.

Fig. 192. *Neopanorpa pilosa* Carpenter, preëpiproct of ♂ holotype in U. S. National Museum.

Fig. 193. *Neopanorpa pilosa* Carpenter, genital bulb of ♂ holotype in U. S. National Museum.

Fig. 194. *Neopanorpa chelata* Carpenter, genital bulb of ♂ paratype in M. C. Z., Cambridge.

Fig. 195. *Neopanorpa chelata* Carpenter, genital bulb of ♂ paratype, showing aedeagus, in M. C. Z., Cambridge.

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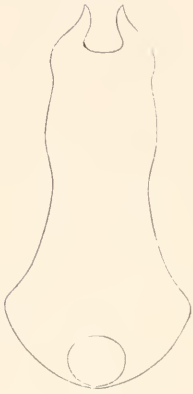

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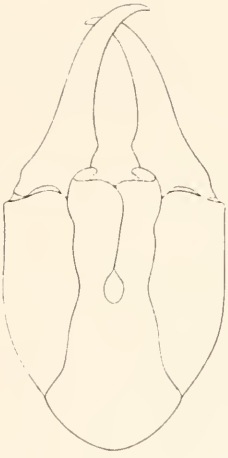

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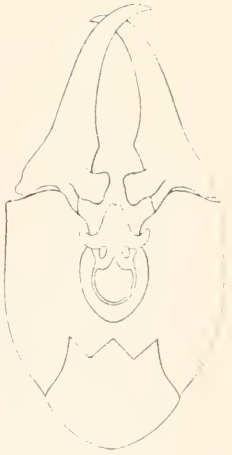

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PLATE 14

PLATE 15

Fig. 196. *Neopanorpa maai* n. sp., subgenital plate of ♀ allotype in Museum of National Foochow University, Foochow.

Fig. 197. *Neopanorpa translucida* n. sp., subgenital plate of ♀ allotype in Museum of National Foochow University, Foochow.

Fig. 198. *Neopanorpa kwangtsehi* n. sp., subgenital plate of ♀ holotype in Maa Collection, Taipeh.

Fig. 199. *Neopanorpa latipennis* Cheng, subgenital plate of ♀ holotype in Cheng Collection, Taipeh.

Fig. 200. *Neopanorpa maai* n. sp., internal skeleton of ♀ allotype in Museum of National Foochow University, Foochow.

Fig. 201. *Neopanorpa translucida* n. sp., internal skeleton of ♀ allotype in Museum of National Foochow University, Foochow.

Fig. 202. *Neopanorpa kwangtsehi* n. sp., internal skeleton of ♀ holotype in Maa Collection, Taipeh.

Fig. 203. *Neopanorpa latipennis* Cheng, internal skeleton of ♀ holotype in Cheng Collection, Taipeh.

Fig 204. *Neopanorpa caveata* n. sp., internal skeleton of ♀ allotype in Museum of National Foochow University, Foochow.

Fig. 205. *Neopanorpa mutabilis* n. sp., internal skeleton of ♀ allotype in Museum of National Foochow University, Foochow.

Fig. 206. *Neopanorpa pielina* Navas, internal skeleton of ♀ paratype in Heude Museum, Shanghai.

Fig. 207. *Neopanorpa nigritis* Carpenter, internal skeleton of ♀ paratype in M. C. Z., Cambridge.

Fig. 208. *Neopanorpa caveata* n. sp., subgenital plate of ♀ allotype in Museum of National Foochow University, Foochow.

Fig. 209. *Neopanorpa mutabilis* n. sp., subgenital plate of ♀ allotype in Museum of National Foochow University, Foochow.

Fig. 210. *Neopanorpa pielina* Navas, subgenital plate of ♀ paratype in Heude Museum, Shanghai.

Fig. 211. *Neopanorpa nigritis* Carpenter, subgenital plate of ♀ paratype in M. C. Z., Cambridge.

Fig. 212. *Neopanorpa heii* Cheng, internal skeleton of ♀ allotype in Cheng Collection, Taipeh.

Fig. 213. *Neopanorpa heii* Cheng, subgenital plate of ♀ allotype in Cheng Collection, Taipeh.

Fig. 214. *Neopanorpa varia* Cheng, internal skeleton of ♀ holotype in Cheng Collection, Taipeh.

Fig. 215. *Neopanorpa varia* Cheng, subgenital plate of ♀ holotype in Cheng Collection, Taipeh.

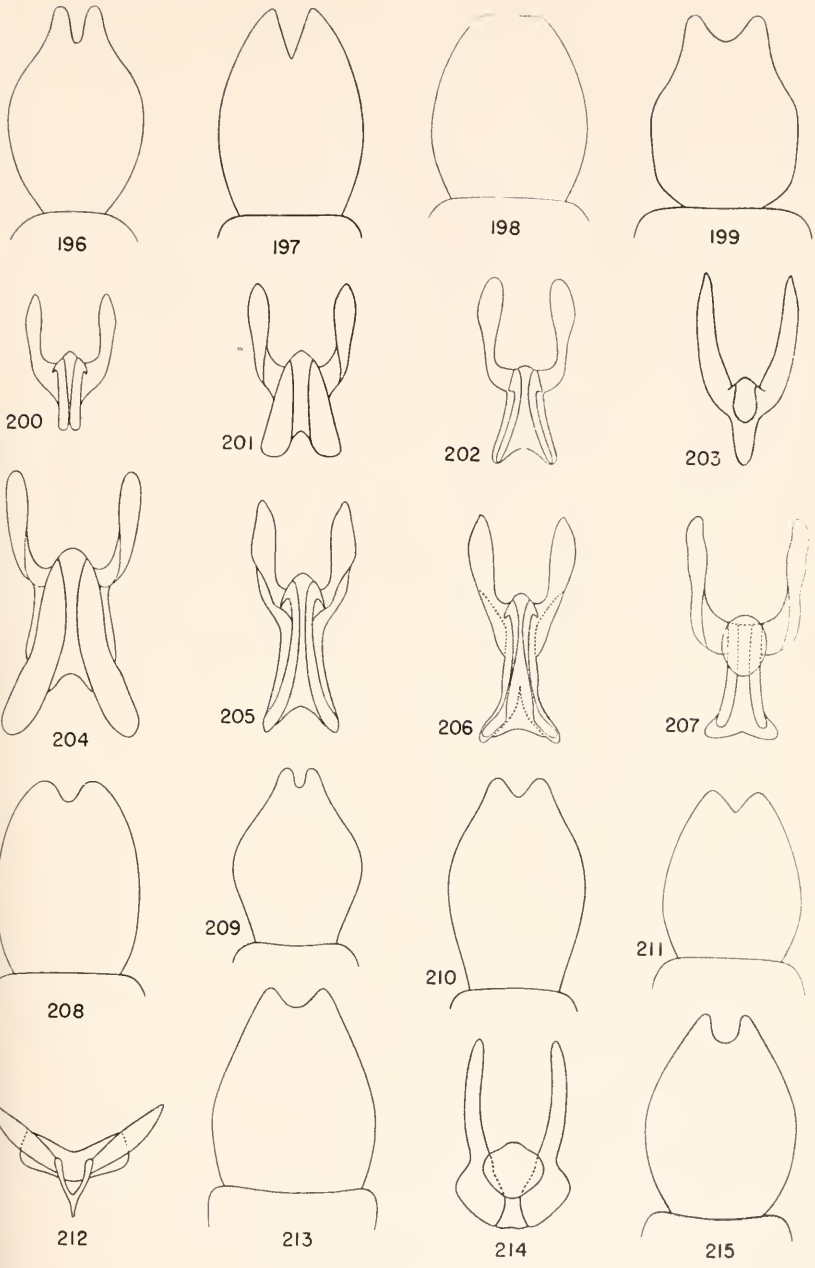
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PLATE 15

PLATE 16

Fig. 216. *Neopanorpa chelata* Carpenter, median process of the 3rd abdominal tergite of ♂ paratype in M. C. Z., Cambridge.

Fig. 217. *Neopanorpa validipennis* Cheng, median process of 3rd abdominal tergite (dorsal view) of ♂ holotype in Cheng Collection, Taipeh

Fig. 218. *Neopanorpa translucida* n. sp., median process of the 3rd abdominal tergite of ♂ holotype in Museum of National Foochow University, Foochow.

Fig. 219. *Neopanorpa nigritis* Carpenter, median process of 3rd abdominal tergite of ♂ paratype in M. C. Z., Cambridge.

Fig. 220. *Neopanorpa maai* n. sp., median process of 3rd abdominal tergite of ♂ holotype in Museum of National Foochow University, Foochow.

Fig. 221. *Neopanorpa mutabilis* n. sp., median process of 3rd abdominal tergite of ♂ holotype in Museum of National Foochow University, Foochow.

Fig. 222. *Neopanorpa validipennis* Cheng, median process of 3rd abdominal tergite (lateral view) of ♂ holotype in Cheng Collection, Taipeh.

Fig. 223. *Neopanorpa translucida* n. sp., preëpiproct of ♂ holotype in Museum of National Foochow University, Foochow.

Fig. 224. *Neopanorpa maai* n. sp., preëpiproct of ♂ holotype in Museum of National Foochow University, Foochow.

Fig. 225. *Neopanorpa pielina* Navas, preëpiproct of ♂ paratype in Heude Museum, Shanghai.

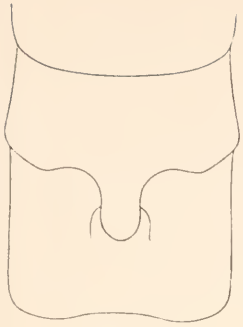
Fig. 226. *Neopanorpa mutabilis* n. sp., preëpiproct of ♂ holotype in Museum of National Foochow University, Foochow.

Fig. 227. *Neopanorpa validipennis* Cheng, preëpiproct of ♂ holotype in Cheng Collection, Taipeh.

Fig. 228. *Leptopanorpa javanica* (Westwood), genital bulb of ♂ identified specimen from Noesa Kambangan, Java, after Lieftinek in Esben-Petersen Collection, Silkeborg.

Fig. 229. *Leptopanorpa javanica* (Westwood), internal skeleton of ♀ identified specimen from Noesa Kambangan, Java, after Lieftinek.

Fig. 230. *Bittacus appendiculatus* Esben-Petersen, genital segment of ♂ type after Esben-Petersen in his collection, Silkeborg.



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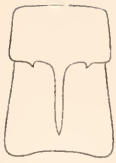

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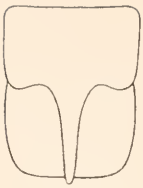

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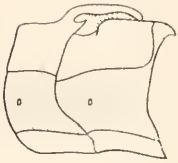

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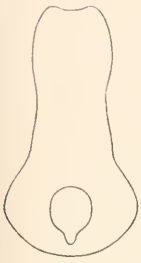

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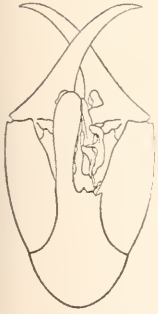

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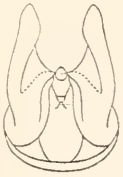

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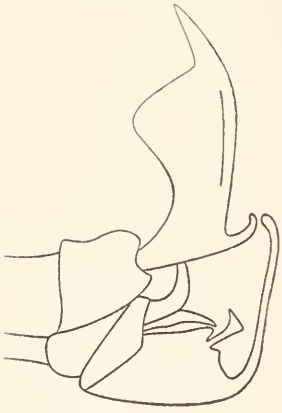

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PLATE 16

PLATE 17

Fig. 231. *Bittacus zoensis* n. sp., genital segment (lateral view) of ♂ holotype in Heude Museum, Shanghai.

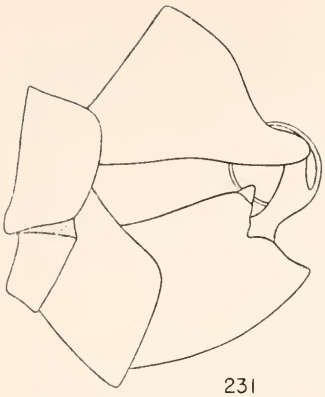
Fig. 232. *Bittacus tienmushana* n. sp., genital segment (lateral view) of ♂ holotype in Museum of Institute of Zoology, Academia Sinica, Shanghai.

Fig. 233. *Bittacus triangularis* Issiki, genital segment (lateral view) of ♂ identified specimen from Keizyo, Korea, in Issiki Collection, Tokyo.

Fig. 234. *Bittacus coreanus* Issiki, genital segment (lateral view) of ♂ identified specimen from Keizyo, Korea, in Issiki Collection, Tokyo.

Fig. 235. *Bittacus sinensis* Walker, genital segment (lateral view) of ♂ identified specimen from Chusan, Chekiang, in Cheng Collection, Taipeh.

Fig. 236. *Bittacus gressitti* n. sp., genital segment (lateral view) of ♂ holotype in M. C. Z., Cambridge.



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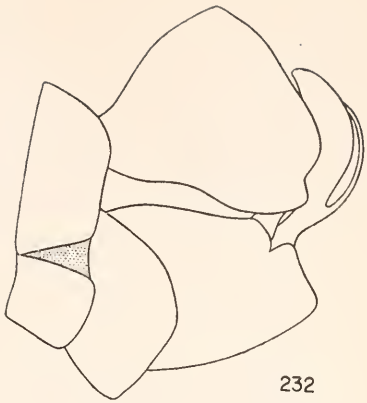

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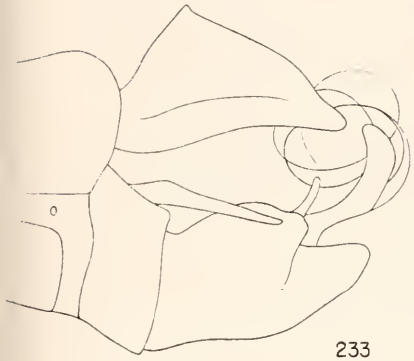

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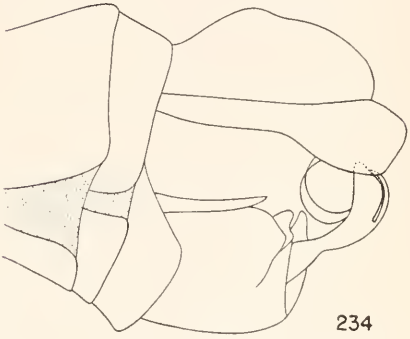

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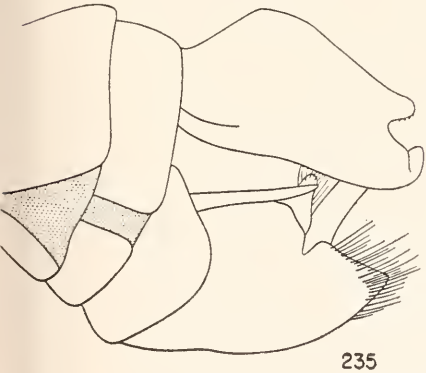

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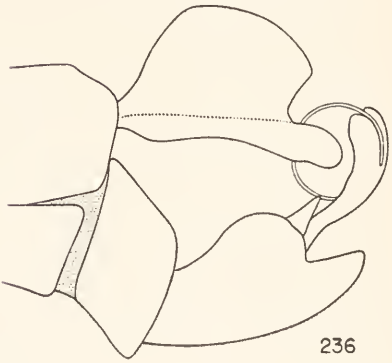

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PLATE 17

PLATE 18

Fig. 237. *Bittacus sinensis* Walker, proetiger and lower process of ♂ identified specimen from Chusan, Chekiang, in Cheng Collection, Taipeh.

Fig. 238. *Bittacus sinicus* Issiki, proetiger and lower process of ♂ identified specimen from Jihti, Sikang, in Cheng Collection, Taipeh.

Fig. 239. *Bittacus planus* Cheng, proetiger and lower proeess of ♂ holotype in Cheng Collection, Taipeh.

Fig. 240. *Bittacus coreanus* Issiki, proetiger and lower proeess of ♂ identified specimen from Keizyo, Korea, in Issiki Collection, Tokyo.

Fig. 241. *Bittacus triangularis* Issiki, proetiger and lower process of ♂ identified specimen from Keizyo, Korea, in Issiki Collection, Tokyo.

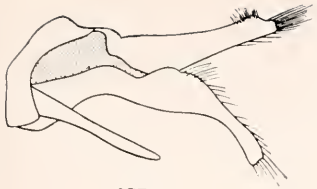
Fig. 242. *Bittacus pieli* Navas, proetiger and lower process of ♂ paratype in Heude Museum, Shanghai.

Fig. 243. *Bittacus pieli* Navas, genital segment (lateral view) of ♂ paratype in Heude Museum, Shanghai.

Fig. 244. *Bittacus planus* Cheng, genital segment (lateral view) of ♂ holotype in Cheng Collection, Taipeh.

Fig. 245. *Bittacus sinicus* Issiki, genital segment (lateral view) of ♂ identified specimen from Jihti, Sikang in Cheng Collection, Taipeh.

Fig. 246. *Bittacus carpenteri* n. sp., genital segment (lateral view) of ♂ holotype in M. C. Z., Cambridge.



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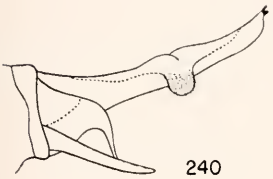

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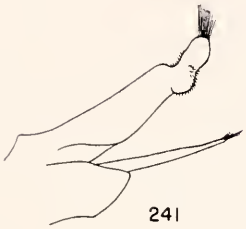

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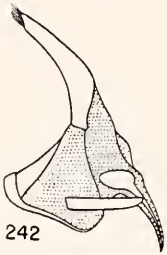

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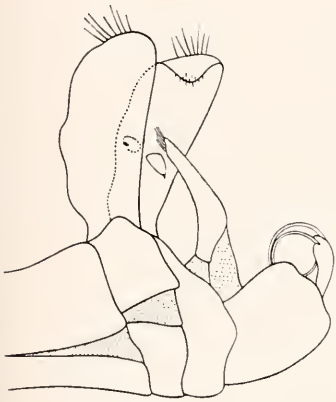

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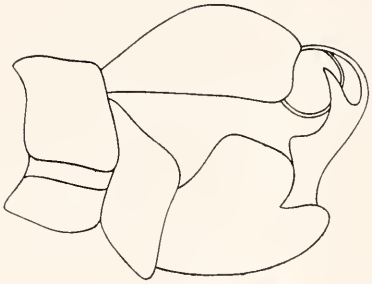

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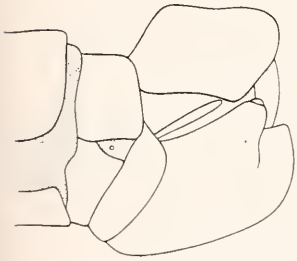

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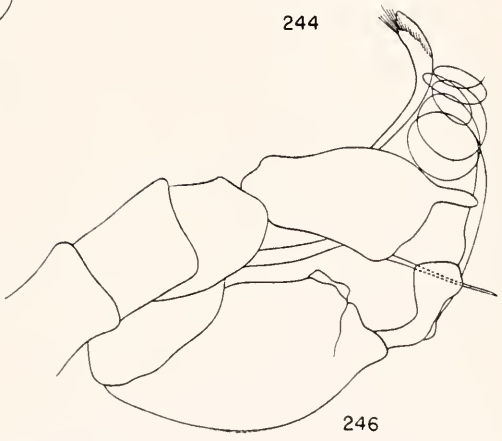

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PLATE 18

PLATE 19

Fig. 247. *Bittacus coreanus* Issiki, genital segment (caudal view) of ♂ identified specimen from Keizyo, Korea, in Issiki Collection, Tokyo.

Fig. 248. *Bittacus planus* Cheng, genital segment (caudal view) of ♂ holotype in Cheng Collection, Taipeh.

Fig. 249. *Bittacus sinicus* Issiki, genital segment (caudal view) of ♂ identified specimen from Jihti, Sikang in Cheng Collection, Taipeh.

Fig. 250. *Bittacus pieli* Navas, genital segment (caudal view) of ♂ paratype in Hende Museum, Shanghai.

Fig. 251. *Bittacus coreanus* Issiki, preëpiproct of ♂ identified specimen from Keizyo, Korea, in Issiki Collection, Tokyo.

Fig. 252. *Bittacus triangularis* Issiki, preëpiproct of ♂ identified specimen from Keizyo, Korea, in Issiki Collection, Tokyo.

Fig. 253. *Bittacus zoensis* n. sp., proctiger and lower process of ♂ holotype in Hende Museum, Shanghai.

Fig. 254. *Bittacus gressitti* n. sp., proctiger and lower process of ♂ holotype in M. C. Z., Cambridge.

Fig. 255. *Bittacus sinensis* Walker, preëpiproct of ♂ identified specimen from Chusan, Chekiang, in Cheng Collection, Taipeh.

Fig. 256. *Bittacus carpenteri* n. sp., preëpiproct of ♂ holotype in M. C. Z., Cambridge.

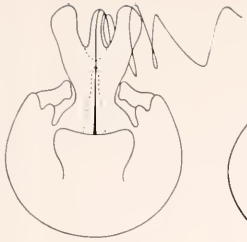
Fig. 257. *Bittacus zoensis* n. sp., preëpiproct of ♂ holotype in Hende Museum, Shanghai.

Fig. 258. *Bittacus planus* Cheng, preëpiproct of ♂ holotype in Cheng Collection, Taipeh.

Fig 259. *Bittacus tienmushana n.* sp., preëpiproct of ♂ holotype in Museum of Institute of Zoology, Academia Sinica, Shanghai.

Fig. 260. *Bittacus gressitti* n. sp., preëpiproct of ♂ holotype in M. C. Z., Cambridge.

Fig. 261. *Bittacus pieli* Navas, preëpiproct of ♂ paratype in Hende Museum, Shanghai.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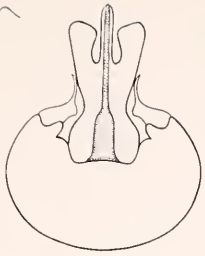
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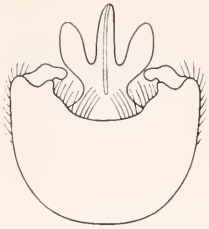
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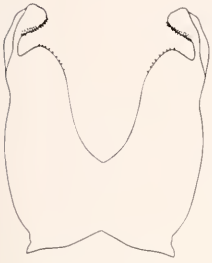
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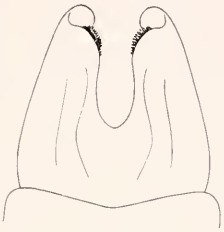
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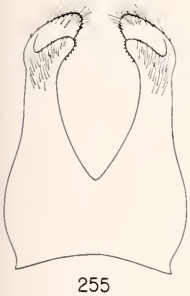
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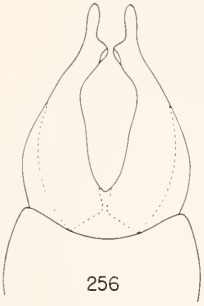
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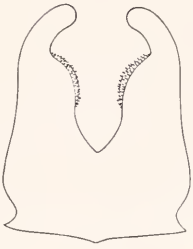
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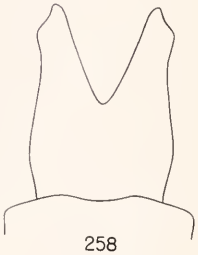
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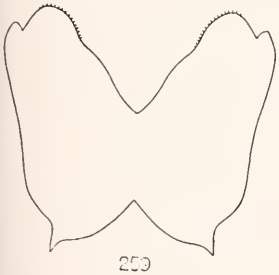
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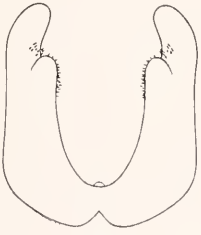
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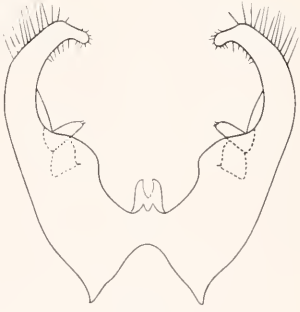
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PLATE 19

PLATE 20

Fig. 262. *Bittacus carpenteri* n. sp., proctiger and lower process of ♂ holotype in M. C. Z., Cambridge.

Fig. 263. *Bittacus tienmushana* n. sp., proctiger and lower process of ♂ holotype in Museum of Institute of Zoology, Academia Sinica, Shanghai.

Fig. 264. *Bittacus sinicus* Issiki, preëpiproct of ♂ identified specimen from Jihti, Sikang, in Cheng Collection, Taipeh.

Fig. 265. *Bittacus zoensis* n. sp., genital segment (caudal view) of ♂ holotype in Heude Museum, Shanghai.

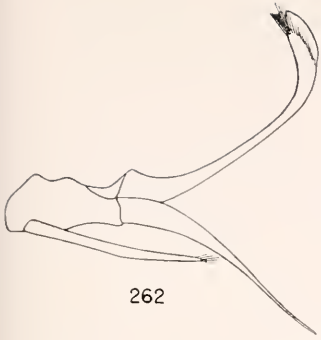
Fig. 266. *Bittacus gressitti* n. sp., genital segment (caudal view) of ♂ holotype in M. C. Z., Cambridge.

Fig. 267. *Bittacus triangularis* Issiki, genital segment (caudal view) of ♂ identified specimen from Keizyo, Korea, in Issiki Collection, Tokyo.

Fig. 268. *Bittacus tienmushana* n. sp., genital segment (caudal view) of ♂ holotype in Museum of Institute of Zoology, Academia Sinica, Shanghai.

Fig. 269. *Bittacus carpenteri* n. sp., genital segment (caudal view) of ♂ holotype in M. C. Z., Cambridge.

Fig. 270. *Bittacus sinensis* Walker, genital segment (caudal view) of ♂ identified specimen from Chusan, Chekiang, in Cheng Collection, Taipeh.



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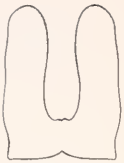

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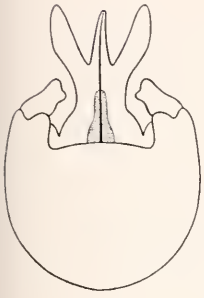

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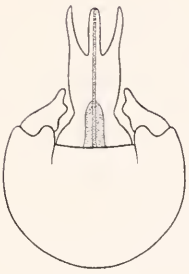

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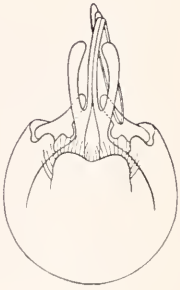

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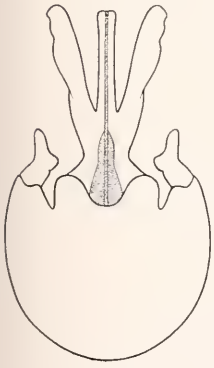

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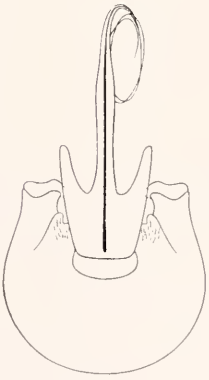

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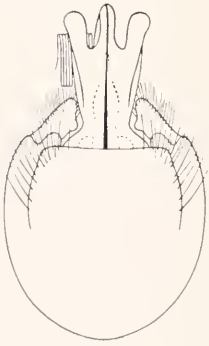

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PLATE 20

PLATE 21

Panorpidae, fore wings

Fig. 271. *Panorpa kimminsi* Carpenter.
Fig. 272. *Panorpa obtusa* Cheng.
Fig. 273. *Panorpa emarginata* Cheng.
Fig. 274. *Panorpa semifasciata* Cheng.
Fig. 275. *Panorpa lcei* Cheng.
Fig. 276. *Panorpa typicoides* Cheng.
Fig. 277. *Panorpa waongkehzengi* Navas.
Fig. 278. *Panorpa sexspinosa* Cheng.
Fig. 279. *Panorpa statura* Cheng.
Fig. 280. *Panorpa implicata* n. sp.
Fig. 281. *Panorpa aurea* n. sp.
Fig. 282. *Panorpa coomani* n. sp.
Fig. 283. *Panorpa trifasciata* n. sp.
Fig. 284. *Panorpa cladocerca* Navas.
Fig. 285. *Panorpa baohwashana* n. sp.
Fig. 286. *Panorpa japonica* Thunberg.

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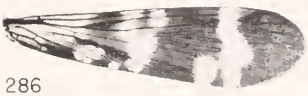

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PLATE 21

PLATE 22

Panorpidae, fore wings

Fig. 287. *Neopanorpa nigritis* Carpenter.
Fig. 288. *Neopanorpa validipennis* Cheng.
Fig. 289. *Neopanorpa kwangtschi* n. sp.
Fig. 290. *Neopanorpa caveata* n. sp.
Fig. 291. *Neopanorpa huangshana* n. sp.
Fig. 292. *Neopanorpa tienmushana* n. sp.
Fig. 293. *Neopanorpa hcii* Cheng.
Fig. 294. *Neopanorpa varia* Cheng.
Fig. 295. *Neopanorpa translucida* n. sp.
Fig. 296. *Neopanorpa maai* n. sp.
Fig. 297. *Neopanorpa latipennis* Cheng.
Fig. 298. *Neopanorpa orata* n. sp.
Fig. 299. *Neopanorpa chelata* Carpenter.
Fig. 300. *Neopanorpa carpenteri* n. sp.
Fig. 301. *Neopanorpa pielina* Navas.
Fig. 302. *Neopanorpa cantonensis* n. sp.

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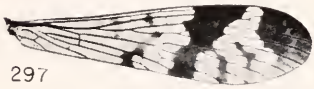

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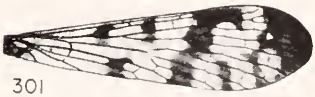

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PLATE 22

PLATE 23

Bittacidae, fore wings

Fig. 303. *Bittacus sinensis* Walker.
Fig. 304. *Bittacus tianmushana* n. sp.
Fig. 305. *Bittacus planus* Cheng.
Fig. 306. *Bittacus zoensis* n. sp.
Fig. 307. *Bittacus carpenteri* n. sp.
Fig. 308. *Bittacus pieli* Navas.
Fig. 309. *Bittacus coreanus* Issiki.
Fig. 310. *Bittacus triangularis* Issiki.
Fig. 311. *Bittacus sinicus* Issiki.
Fig. 312. *Bittacus gressitti* n. sp.

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PLATE 23

Bulletin of the Museum of Comparative Zoology
AT HARVARD COLLEGE
Vol. 116, No. 2

A CATALOGUE OF THE CERIONIDAE (MOLLUSCA-PULMONATA)

By William J. Clench

CAMBRIDGE, MASS., U. S. A.
PRINTED FOR THE MUSEUM
April, 1957

Publications Issued by or in Connection
with the

MUSEUM OF COMPARATIVE ZOOLOGY
AT HARVARD COLLEGE

Bulletin (octavo) 1863 — The current volume is Vol. 115.

Breviora (octavo) 1952 — No. 73 is current.

Memoirs (quarto) 1864–1938 — Publication was terminated with Vol. 55.

Johnsonia (quarto) 1941 — A publication of the Department of Mollusks. Vol. 3, no. 35 is current.

Occasional Papers of the Department of Mollusks (octavo) 1945 — Vol. 2, no. 21 is current.

Proceedings of the New England Zoölogical Club (octavo) 1899–1948 — Published in connection with the Museum. Publication terminated with Vol. 24.

The continuing publications are issued at irregular intervals in numbers which may be purchased separately. Prices and lists may be obtained on application to the Director of the Museum of Comparative Zoology, Cambridge 38, Massachusetts.

Of the Peters "Check List of Birds of the World," volumes 1-3 are out of print; volumes 4 and 6 may be obtained from the Harvard University Press; volumes 5 and 7 are sold by the Museum, and future volumes will be published under Museum auspices.

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INTRODUCTION

The Cerionidae, a family of terrestrial pulmonate Gastropoda, are found on certain islands of the West Indies and the southern Keys of Florida from Miami south and west to the Dry Tortugas. It is the only family of land mollusks peculiar to the West Indies.[1]

They are halophiles and are seldom found more than a few hundred feet from the sea. In the Bahamas, however, they may occur at a much greater distance inland, particularly in lowland areas where salt spray can reach them from more than one direction.

This family contains but a single genus with a few subgenera and a vast number of "species" and "subspecies." Probably less than 20 per cent of the names now extant actually apply to valid species or subspecies. The task ahead for anyone attempting to monograph this group is rather appalling due to the fact that the characters generally held stable in most other groups of mollusks are, in this group, wildly rampant. Many recent as well as early describers, the present author included, are and were completely oblivious to the remarkable plasticity of this group of mollusks. I think that, in this genus, nature is isolating or mixing small elements of *Cerion* populations as effectively as man has done with his domesticated plants and animals. *Cerion* lives mainly along the upper strand line, an exceedingly hazardous area to occupy in any region where hurricanes occur. Here, for short or long periods of time, they may build up strong, vigorous colonies. The appalling devastation of a hurricane in the strand line is quite apparent to even a casual observer. In such an area, a colony may be greatly reduced or even completely exterminated. The same storm may move elements of this colony to a new region and bring in other elements of the genus from distant places by means of flotsam. This is certainly the way it

1 In essence, the lower Florida Keys are mainly West Indian in both their fauna and flora. I do not know of any permanent colonies of *Cerion* living on the Florida mainland.

appears to those of us fortunate in having had extensive field experience in the West Indian region. Such a statement is, of course, difficult to prove, but the facts of distribution still remain and their haphazard distributional patterns seem to offer no other reasonable explanation. Like all other land pulmonates, the larval stages are passed within the egg; there is no "free swimming" stage. Their distribution, beyond their ability to migrate within a narrow ecological niche, is exceedingly limited as far as their own mobile power is concerned. Their broader distribution is brought about entirely by mechanical means. A five-foot stream would be an absolute barrier without such means of transport.

The morphological characters of the shell appear to be exceedingly variable and most of the differences are certainly more apparent than real. Few, if any, of these characters, such as size, degree of costation, coloration, position of the apertural teeth, convexity of the spire, or the ratio between height and width, are at all stable.

We must take a realistic stand regarding the naming of various elements in this genus. We are not dealing with a "normal" group so far as the usual specific characters are concerned, but rather with a group of mollusks existing under natural conditions that closely approximate the control and isolation which have brought about man's domesticated animals and plants.

HISTORICAL SUMMARY

As for most of our widely distributed West Indian molluscan genera the early work in this group began in the late 18th century. Surprisingly enough, however, only a very few of the many named forms that now exist found their way into the European cabinets prior to 1850. But even at this time, few names had reached the printed page and these few were the result mainly of the indefatigable Cuban collector Juan Gundlach. Much of coastal Cuba was then nearly inaccessible, at least from the land side, and such named forms were described from localities mainly within easy walking distance of the larger coastal cities. At this time, little was known of the richness of the Bahama Archipelago. Early monographers, such as Küster in the Conchylien Cabinet (1841-50) and Sowerby (1875-76) in

the Conchologica Iconica tabulated such species as were then known without any serious attempt to group them into natural assemblages. This task was first accomplished by Pilsbry in the Manual of Conchology, 1901-02. Prior to the work of Pilsbry, Maynard (1889) started such a study but the several new forms that he described over the course of many years, from 1889 to 1924, completely submerged his original attempt at such a complete classification. His work was marred by many inaccuracies of all kinds and his attempts toward a clarification of this complex problem dwindled as the years passed, ending in brief descriptions and eventually in a sales catalogue with a few "new species" described. In fairness to Maynard, however, the commercial side of his venture was not to gain profit for himself but to realize money to finance additional expeditions in quest of these mollusks in which he was so deeply interested. It seems to me that Maynard failed to grasp much of the importance of his own discoveries. He failed to see that he was actually dealing with unit populations and not with completely isolated entities which he had termed "species." Somewhere in his writings he mentioned that a wagon road on New Providence was a complete barrier between two of his named "species." But he overlooked the caprice of a single hurricane and the consequent mixing of these two populations. Nevertheless, we owe much to Maynard for his early exploration of both the Bahama Islands and the Cayman Islands, as the specimens he collected are still the only materials available for study from many remote and inaccessible localities.

It is most unfortunate that his writings were privately published and had a very limited sale. He not only wrote the text, but cut his own wood blocks, and with a small printing press set his own type and printed his publications. His collection was purchased from his daughter jointly by the Museum of Comparative Zoology and the United States National Museum in 1931.

After 1900 many students besides Maynard and Pilsbry added materially to the names in this genus; Dall, Bartsch, Plate, and Clench for the Bahama Archipelago and Aguayo, Sánchez Roig, Jaume and Clench for Cuba. Many names were added by H. B. Baker to the *uva* complex of the Dutch West Indies, Curacao and its associated islands.

Mr. Allison V. Armour's yacht, the *Utowana,* made several trips to various islands in the Bahamas and by this means much *Cerion* material was collected for this museum mainly by T. Barbour and J. C. Greenway.

In 1936, Mr. J. C. Greenway and his brother Gilbert made extensive collections in the Bahamas by means of a seaplane. Islands visited were Andros, Grand Bahama, the Abacos, Great and Little Inagua. I joined them for the exploration of Grand Bahama and the Abacos. During this same trip I visited also Eleuthera Island. A year previously I had explored rather extensively the northern end of Cat Island and Little San Salvador or Little Island. I was associated on this trip with Henry D. Russell and John Huntington. Later, students and associates of mine visited Long Island (Richard W. Foster, Richard McLean and John Huntington) and Great and Little Inagua (Richard McLean and Benjamin Shreve). Each of these various trips necessitated several days in Nassau, and much time was devoted to collecting *Cerion* and other mollusks outside of this city on New Providence Island.

In 1907, Dr. Plate published upon a few species obtained on islands in the Exuma group. During the summer of 1930, Dr. Paul Bartsch of the United States National Museum made an extensive collecting trip in the southern Bahamas visiting such island groups as: Cay Sal Bank, Ragged Islands, Crooked Island group, Little and Great Inagua, Caicos and Turks Islands. More recently, Mr. and Mrs. George F. Kline of Madison, New Jersey, have added to our series of *Cerion* from a few islands in the Exuma group and from cays in the Ragged Islands, Bahamas.

Many others have figured in the exploration of the Bahamas, mainly with other interests in mind but, nevertheless, much data in the form of material have been collected which will aid in the eventual solution of this mollusk problem. More data on the historical side are available in the various studies which are listed in the bibliography.

There are but three centers of "speciation" at the present time, for this genus: Cuba, the Bahamas and the Cayman Islands. In these islands the greatest number of populations occur. Elsewhere, such as Hispaniola, Puerto Rico and the Virgin Islands populations are exceedingly few and all appear to be very closely related. On both Hispaniola and Puerto Rico they

are to be found only on the south coasts. It is quite astonishing that this genus has failed to invade Jamaica.

At this time only a single group in this complex has been analyzed (Clench and Aguayo, 1952) : the subgenus *Umbonis*. This group is limited to the north coast of Cuba and the Bahamas. Distributional patterns for the species in this group are not at all uniform ; they appear to be hit or miss and based upon chance introductions.

It is interesting to note that this genus succeeded in invading the Dutch West Indies. These islands are far removed from the Greater Antilles and the established species complex on them is quite different from all others in the genus. It is possible that this was an early introduction and that since then no other members have invaded this area, so that all of the present named entities are exceedingly close in their relationships and appear to be but unit populations of a closely-knit species.

COLLECTIONS

Major collections of *Cerion* are to be found in : the Academy of Natural Sciences, Philadelphia ; American Museum of Natural History, New York City ; Museum of Comparative Zoology, Harvard University ; Museum of Zoology, University of Michigan ; Museo Poey, Universidad de la Habana, Habana, Cuba ; and the United States National Museum, Washington, D.C. Many smaller collections exist in most museums, both in the Americas and in Europe, but the above institutions contain collections that are rich both in type material and in geographical series.

GEOGRAPHIC INDEX

The following list of names is arranged geographically to aid in locating the species of *Cerion* which have been described from any given locality. Names of species now considered synonyms have been omitted from this list. This does not mean that all the names included below refer to valid species but only that to date no attempt has been made to restudy most of these forms since they were originally described. A good example is that of New Providence, Bahamas, given below. Probably no more than

five or six species exist on this small island, yet the present list stands at 82!

Fossil species have been included in this list as most of these "fossil" forms are not old in any geologic sense.

In the list of names below we have retained the original spelling. As *Cerion* is neuter, all the adjectival specific names should end in *um*.

BAHAMA ISLANDS

Andros Island

albata
bimarginata
capraia
carnale
casablancae
cera
columbiana
crescentia
evolva
grisea
helena
irregulare
latisinus
lenticularia
normale
obesum
panda
pepperi
persuasa
pilsbryi
pupilla
regula
restricta
rhyssum
saurodon
sladeni
stupida
variabile
viaregis

Berry Islands

albolabra
arbusta
aviaria
balaene
berryense
caduca
cana
candida
confusa
intercalaria
jenneyi
litorea
lobata
mixta
obtusa
picturata
plebia
porcina
primordia
proavita
procliva
profunda
rara
relequa
scutata
sylvatica
thayeri
travelii
variata

Bimini Islands

biminiensis
lerneri
pillsburyi

Caicos Islands

caicosense

Castle Island

regia

Cat Island

eximea
felis
fordii
fraternum
huntingtoni
platei
russelli

CAY SAL BANK

niteloides

CONCEPTION ISLAND

fairchildi

CROOKED ISLAND

cliffordi
inflata
marmorata
martensi
multistriatum
weinlandi

ELEUTHERA ISLAND

eleutherae
exigua
glans
hughesi
hyattii
inconsueta
indianorum
laeve
liliorum
mossi
multa
uniformis

EXUMA GROUP OF ISLANDS

accuminator
agricola
albicostata
aspera
cervina
crassa
cyclura
cylindriata
degenis
dissimila
eburnia
elegantissima
elongata
exorta
extranea
extrema
fitzgeraldi
fruticosa
fulvia
genitiva
gigantea
grayi
hedwigiae
imperfecta
inconstans
inexpecta
inornata
inquita
intentata
leucophera
mariae
marmorosa
milleri
minuta
mitra
mutatoria
navalis
nebula
normanii
palmata
perantiqua
processa
prognata
progressa
pumilia
ritchiei
sampsoni
sealariformis
similaria
stroutii
tenuecostata
valida
veta

FORTUNE ISLAND

submarmoratum

GRAND BAHAMA ISLAND

chrysaloides
oweni

GREAT ABACO ISLAND

abacoensis
bendalli
lucayanorum
maynardi
reticulatum
vermiculum

GREAT EXUMA ISLAND

adumbra
caerulescens
exasperata
exumense
flamea
fragilis
pauli
plegmatum
pulla
pusilla
recessa
semipolita
transmutata

GREAT INAGUA ISLAND

columna
dallii
rehderi
rubicunda
turnerae
valida
viola

GREEN CAY

scalarinoides
universa

JOULTER CAYS

ralla

LITTLE ABACO ISLAND

incisum
oweni

LITTLE INAGUA ISLAND

baconi
calcarea
sarcostomum
shrevei

LONG ISLAND

fernandina
josephinae
malonei
melcani
melanostomum
nuda
stevensoni

MIRAGUANA ISLAND

armouri
barbouri
mariguanense
piraticus

MIRA POR VOS CAY

periculosum

NEW PROVIDENCE AND ADJACENT ISLANDS

acceptoria
affinis
agassizi
agava
agava-neglecta
agrestina
ajax
albata
albea
angustalabra
antiqua
argentia
avita
caerulea
carlotta
castra
cinerea
cinerea-varia
clara
fincastlei
flacida
fulminea
glans
gracila
gubernatoria
hart-bennetii
hesternia
larga
latonia
leva
livida
macularia
mayoi
migratoria
minima
mobile
montana
morula
palidula
phoenecia
primigenia
prisca
purpurea
pygmea
rediviva
reincarnata
repetita
rosacea
rosea
rubiginosa
rufimaculata
rufula
salinaria
santesoni
saxitina
sparsa
sula

concina
coryi
crassalabra
curtissii
degeneri
delicata
devereuxi
eratica
extensa
multa
muralia
mutata
neglecta
nivea
novita
oberholseri
oscula
tenui
territa
thompsoni
thorndikei
tracta
ultima
vagabunda
vetusta

Plana Cays

utowana

Ragged Islands

juliae

Rum Cay

alba
brownei
lentiginosa

Samana Cay

greenwayi

Turks Islands

blandi
brevispira
comes
eucosmium
incanoides
percostatum
regina
swiftii

Watling Island

inconspicuum
lacunorum
watlingense

CAYMAN ISLANDS

Cayman Brac

copia
glaber
intermedia
lineota
parva
perplexa

Grand Cayman

caymanense
martiniana

Little Cayman

acuta
festiva
fusca
intermedia
levigata
lineota
nana
nitela
pannosa
picta

CUBA

Camagüey Province

acuticostatum
bioscai
columbinus
cuspidata
miramarae
palmeri
paredonis
pastelilloensis
sanctacruzense
sanzi
saugeti
scopulorum

dorotheae
grilloensis
gundlachi
pretiosus
sainthilarius
sellare
tantillum

Habana Province

ceiba
eurystoma
fastigata
ignota
jaumei
noriae
peracutum
ricardi
rocai
salvatori
striatissimum
tridentatum

Isle of Pines

moreleti
pineria

Las Villas Province

alcaldei
arangoi
bermudezi
catherwoodianum
chaplini
cyclostomum
ebriolum
herrerai
iostoma
macrodon
poeyi
pseudocyclostomum
saguaense
sanctamariae
strigis
subcostulatum

Matanzas Province

alcaldei
canasiense
cardenense
caroli
dickersoni
guillermi
hologlyptum
infanda
infandulum
ludovici
magister
maritima
microstomum
minusculum
mumiola
obliterata
sagraiana
scripta
sublaevigatum
valdesi

Oriente Province

aguayoi
alberti
alleni
banesense
basistriatum
bequaerti
blanesi
cabocruzense
chaparra
cobarrubia
contini
crassiusculum
dimidiata
disforme
feltoni
feriai
geophilus
harringtoni
hessei
humberti
jaucoense
josephi
lepidum
longidens
manatiense
microdon
moralesi
orientale
ornatum
pandionis
parvulum
paucicostatum
pauciculptum
polita
portillonis
portuspatris
prestoni
proteus
ramsdeni
saetiae
scalarina
smithii
sueyrasi
tanamensis
tenuilabris
torrei
turgidum
vallei
vanattai
victor

PINAR DEL RIO PROVINCE

cabrerai	hernandezi	marielinum
cisnerosi	hondana	sculpta
constrictum	johnsoni	sisal
dominicanum	laureani	wrighti

CUBA (WITHOUT SPECIFIC LOCALITY)

hyperlissum	kusteri	venusta
inerassata		

DUTCH WEST INDIES

ARUBA

arubanum

BONAIRE

bonairensis	kralendijki	

CURACAO

desculptum	djerimensis	knipensis
diablensis	hatoensis	uva

FLORIDA

incana	saccharimeta	vaccinum

HISPANIOLA

ferruginea	sallei	tortuga
minor	saona	yumaensis

MONA ISLAND

monaense

PUERTO RICO

striatella

VIRGIN ISLANDS

rudis	striatella

NOTES ON THE GENUS *CERION*

The following notes are based upon studies in this genus which were made during a rehabilitation of certain portions of our collection.

Subgenus Strophiops Dall

Strophiops Dall 1894, Bull. Mus. Comp. Zool., **25**, p. 121 (type species, *Pupa decumana* Férussac (=*C. regium*) Castle Island, Bahamas).

Pinguita Maynard 1896, Contributions to Science, **3**, p. 30 (type species, *Strophia dimidiatia* [*sic*] Pfeiffer, monotypic).

Cyclocerion Bartsch 1952, Revista de la Sociedad Malacológica "Carlos de la Torre," **9**, p. 1 (type species, *Cerion* (*Cyclocerion*) *baconi* Bartsch).

Both *Pinguita* Maynard and *Cyclocerion* Bartsch appear to be absolute synonyms of *Strophiops* Dall. This group is widely spread in the Bahamas and along the northern coast of Cuba.

Cerion sanctacruzense Aguayo and Jaume

Cerion sanctacruzense Aguayo and Jaume 1951, Revista de la Sociedad Malacológica "Carlos de la Torre," **8**, p. 14, pl. 1, fig. 14 (Sabanalamar, Santa Cruz del Sur, Camagüey, Cuba).

This species was described from Sabanalamar, which is just east of Santa Cruz del Sur on the southern coast of Camagüey, Cuba. It appears to be rather widespread in the Cayos de Doce Leguas, a long series of small islands that run westerly and just off the coast from Santa Cruz del Sur. Typical *sanctacruzense* are smooth, but numerous colonies from the various islands are both smooth and strongly ribbed. We have specimens from the following localities: Sabanalamar; Santa Cruz del Sur; Cayo Caguama; Cayo Cochiboca; Punta Boca de Piedra and Cayo Anclitas.

Cerion politum Maynard

Strophia marmorata polita Maynard 1896, Contributions to Science, **3**, p. 14, pl. 3, figs. 3-4 (Cabo Cruz, Cuba).

Cerion politum maisianum Pilsbry 1902, Manual of Conchology, (2) **14**, p. 218, pl. 30, figs. 89-91 (Punta Maisi, Cuba).

Both of the above names apply to the same species. Maynard was in error in giving the type locality as Cabo Cruz. This species occurs only at Punta de Maisi, at the extreme eastern end of Cuba. In color it ranges from nearly pure white to marbled with brownish. Both smooth and finely ribbed forms occur in different colonies as well as mixed in others.

Cerion alleni Torre

Cerion alleni Torre 1929, Nautilus, **42**, no. 3, pl. 4, figs. 10-11 [no description] (Antilla, Cuba).

Cerion madama Sánchez Roig 1951, Revista de la Sociedad Malacológica "Carlos de la Torre," **7**, p. 112, pl. 18, fig. 9 (Cayo Madama, Bahía Arroyo Blanco, Mayarí, Oriente, Cuba).

Cerion miguelcti Sánchez Roig 1951, Revista de la Sociedad Malacológica "Carlos de la Torre," **7**, p. 113, pl. 19, fig. 5 (Cayo Miguel, Boca de Yaguaneque, Cananova, Sagua de Tánamo, Oriente, Cuba).

Cerion sanchezi Clench and Aguayo 1953, Torreia, no. 18, p. 3, text figs. 4-5, Univ. Habana (Lengua de Pájaro, Bahía de Lebiza, Mayarí, Oriente, Cuba).

All of the above names apply to but a single species. This appears to be a species which is limited to the margins of rather large bays. Its distribution extends from Bahía de Banes east to Bahía de Yaguaneque along the north coast of Oriente, Cuba.

Cerion sanzi Pilsbry and Vanatta

Cerion sanzi Pilsbry and Vanatta 1898 [1899], Proc. Acad. Nat. Sci. Philadelphia, p. 478, text fig. 9 (Confites Key, Nuevitas, Cuba).

Cerion royi Aguayo and Jaume 1951, Revista de la Sociedad Malacológica "Carlos de la Torre," **8**, p. 7, pl. 1, fig. 1 (Cayo Cruz, Camagüey, Cuba).

Cerion circumscriptum Aguayo and Jaume 1951, Revista de la Sociedad Malacológica "de la Torre," **8**, p. 12, pl. 1, fig. 10 (Guanalito, Cayo Romano, Camagüey, Cuba).

Cerion tejedori Sánchez Roig 1951, Revista de la Sociedad Malacológica "Carlos de la Torre," **7**, p. 112, pl. 18, fig. 7 (Punta Arenas, Paso de las Carabelas, Peninsula de Sabinal, Camagüey, Cuba).

Cerion guajabaense Sánchez Roig 1951, Revista de la Sociedad Malacológica "Carlos de la Torre," **7**, p. 114, pl. 18, fig. 6 (Cayo Grillo, Isla de Guajaba, Camagüey, Cuba).

Cerion circumscriptum tenuicallum Aguayo and Sánchez Roig 1953, Mem. Soc. Cubana Hist. Nat., **21**, p. 288, pl. 32, fig. 17 (Cayo Francés, Caibarien, Las Villas, Cuba).

Cerion circumscriptum romanoensis Aguayo and Sánchez Roig 1953, Mem. Soc. Cubana Hist. Nat., **21**, p. 289, pl. 32, figs. 12, 14 (Cayo Romano, Camagüey, Cuba).

Cerion sanzi Pilsbry and Vanatta appears to be the most widely distributed *Cerion* throughout the Archipiélago de Camagüey, a long chain of cays and little islands on the northern coast of Cuba. This chain of cays extends from Cayo Guillermo,

off Punta Alegre to Cayo Sabinal, a distance of 125 miles (200 kilometers).

The synonyms given above all appear to be this species or else hybrid colonies in which the *sanzi* characters are most prominent.

Cerion microdon Pilsbry and Vanatta

Cerion incrassatum microdon Pilsbry and Vanatta 1896, Proc. Acad. Nat. Sci. Philadelphia, p. 328, pl. 11, fig. 5 (Cuba).

Cerion tenuilabre pygmaeum Pilsbry and Vanatta 1896, Proc. Acad. Nat. Sci. Philadelphia, p. 334, pl. 11, fig. 9, (Gibara, Cuba).

The two names given above appear to be the same species. *C. microdon* is exceedingly variable in size and somewhat in coloration. It occurs on both sides of the harbor of Gibara but is very rare on the eastern side. Most of the specimens from the west side were collected dead. At the time Dr. Aguayo and I visited this locality we found even the dead specimens to be localized in certain areas only and not broadly distributed throughout the coastal region of the harbor.

ABBREVIATIONS

A few abbreviations have been found necessary to reduce needless repetition. Other than these, references are given in full under each species.

Catalogue. "Supplement to Catalogue of Specimens of the Family Cerionidae" for sale by Charles J. Maynard, West Newton, Massachusetts. 1924. This supplement includes the descriptions of fourteen new species of *Cerion* without figures.

Contributions. Contributions to Science, By Charles J. Maynard, Newtonville, Massachusetts. A three volume series (discontinued after Vol. 3 no. 1). Published from April 1889 to March 1896. Many new species of *Cerion* were published in this journal.

M. of C. Manual of Conchology (series 2), Academy of Natural Sciences, Philadelphia.

Memorias. Memorias de la Sociedad Cubana de Historia Natural. Museo Poey, Universidad de la Habana, Habana, Cuba.

Proc. ANSP. Proceedings of the Academy of Natural Sciences, Philadelphia.

Records, App. Appendix to Records of Walks and Talks with Nature by C. J. Maynard, West Newton, Massachusetts. In the appendices of volumes 5, 6 and 10 of the above series, there are described and figured numerous species of *Strophiops* (= *Cerion*).

Revista. Revista de la Sociedad Malacológica "Carlos de la Torre" Museo Poey, Universidad de la Habana, Habana, Cuba.

Torreia. Published by Museo Poey, Universidad de la Habana, Habana, Cuba.

Genus CERION Röding

Cerion Röding 1798, Museum Boltenianum, p. 90 (type species, *Turbo uva* Linné, subsequent designation, Dall 1894).

Pupa Lamarck 1801, Animaux sans Vertèbres, p. 88 (type species, *Pupa uva* Linné, monotypic).

Cerium Link 1807, Beschreibung der Naturalien-Sammlung der Universität zu Rostock, p. 131 [emendation for *Cerion*] (type species, *Cerium uva* Linné, subsequent designation, Pilsbry 1918, M. of C. (2) **24**, p. 268).

Puppa Denys de Montfort 1810, Conchyliologie Systematique, **2**, p. 298, Paris (type species, *Pupa uva* Linné, monotypic).

Puparia Rafinesque 1815, Analyse de la Nature, p. 143 [substitute name for *Pupa* Lamarck).

Cochlodonta Férussac 1821, Prodrome, Tableau Systematique des Limaçons, Paris, p. 24 [28] and p. 58 (type species, *Turbo uva* Linné, here selected).

Cochlodon Sowerby 1825, Catalogue of the Shells in the Collection of the Late Earl of Tankerville, London, p. 40 [in part] (type species, *Cochlodon uva* Linné, subsequent designation, Pilsbry 1918, M. of C., (2) **24**, p. 268).

Strophia Albers 1850, Die Heliceen, Berlin, p. 202 (type species, *Pupa mumia* Brugière, subsequent designation, von Martens 1861; non *Strophia* Meigen 1832; Stål 1877).

Pulpa Poey 1858, Memorias sobre la Historia Natural de la Isla de Cuba, Havana, **2**, p. 30 [error for *Pupa* Lam.] (type species, *Pulpa sculpta* Poey, monotypic).

CATALOGUE OF THE CERIONIDAE

abacoensis Pilsbry and Vanatta, *Cerion* (*Maynardia*): 1895, Proc. ANSP, p. 209; *ibid.* 1896, p. 332, pl. 11, fig. 11 (Abaco Island [Bahamas]).

acceptoria Maynard, *Strophiops:* 1913, Records, App., **5**, p. 185 (Low Bay Cay, east end of Rose Island, New Providence, Bahamas).

accuminator Maynard and Clapp, *Strophiops:* 1920, Records, App., **10,** p. 124, pl. 20, figs. 1-2 (Long Cay, Exuma Group, Bahamas).

acuta Maynard, *Strophia:* 1889, Contributions, **1,** p. 15, pl. 2, fig. 4 4b (South side of Little Cayman, Cayman Islands). Is *C. levigatum* Mayn., Pilsbry 1901.

acuticostatum Sánchez Roig, *Cerion scalarinum:* 1948, Revista, **6,** p. 68, pl. 1, fig. 5 (North coast of Cayo Mégano Grande, northern Camagüey, Cuba).

adumbra Maynard, *Strophiops:* 1924, Catalogue, Suppl., p. 2 (Cay south of Green Turtle Cut, Gt. Exuma, Bahamas).

aedilii Aguayo and A. de la Torre, *Cerion caroli:* 1951, Revista, **8,** p. 22, pl. 3, fig. 4 (Boca de Bacunayagua, west of the river, Matanzas Prov., Cuba).

affinis Maynard, *Strophiops:* 1913, Records, App., **5,** p. 184 (Sandy and Green Cays, Rose Island, New Providence, Bahamas).

agassizi Dall, *Cerion* (*Maynardia*): 1894, Bull. Mus. Comp. Zool., **25,** p. 120, figs. 9-10 (west quarry, top of Nassau Ridge, New Providence, Bahamas).

agava Maynard, *Strophia neglecta:* 1894 Contributions, **2,** p. 152, fig. 48 (Sisal fields west of Nassau, New Providence, Bahamas). Is *C. coryi* Mayn., Pilsbry 1902.

agava-neglecta Maynard, *Strophiops:* 1913, Records, App., **5,** p. 192 (Sisal fields west of Nassau, New Providence, Bahamas).

agrestina Maynard, *Strophia:* 1894, Contributions, **2,** p. 179, fig. 60 (6 miles south of Nassau, New Providence, Bahamas).

agricola Maynard, *Strophiops:* 1924, Catalogue, Supplement, p. 1 (Farmers Cay, 1 mile S.W. of Gt. Guana Cay [Exuma Group] Bahamas).

aguayoi de la Torre and Clench, *Cerion:* 1932, Nautilus, **45,** p. 89, figs. 6-7 (Road to Caletones, 6 km. west of Gibara, Oriente, Cuba).

ajax Maynard, *Strophiops:* 1924, Catalogue; p. 5 [new name for *gigantea* Maynard and Clapp 1921, non *gigantea* Maynard 1894].

alba Maynard, *Strophia:* 1899, Contributions, **1,** p. 74, pl. 7, fig. 17a-b (west coast of Rum Cay, Bahamas).

albata Maynard and Clapp, *Strophiops:* May 1921, Records, App., **10,** p. 132, pl. 30, figs. 3-4 (Hog Cay [4 miles N.W. of] Morgans Bluff, Andros, Bahamas).

albata Maynard and Clapp, *Strophiops:* July 1921, Records, App., **10,** p. 145, pl. 41, figs. 7-8 [labeled *vagabunda* on plate] (Southern end of Rose Island, New Providence, Bahamas).

albea Maynard, *Strophia:* 1894, Contributions, **2,** p. 128, fig. 38 (South side of Spruce Key, New Providence, Bahamas). Is *C. varium* Bonnet, Pilsbry 1902.

alberti Clench and Aguayo, *Cerion:* 1949, Torreia, no. **14,** p. 3, pl. 1, figs. 1-6 (Punta de "El Fuerte," entrada de la Bahía de Banes, Peninsula de Ramon, Antilla, Cuba).

albicostata Maynard, *Strophiops:* 1924, Catalogue, Supplement, p. 2 (Long Key, S.E. of Highborn Key [Exuma Group] Bahamas).

albolabra Maynard and Clapp, *Strophiops:* 1921, Records, App., **10,** p. 129, pl. 27, figs. 3-4 (Great Harbor Key, Berry Islands, Bahamas).

alcaldei Aguayo and Sánchez Roig, *Cerion arangoi:* 1953, Memorias, **21,** p. 294, pl. 32, fig. 15 (Playa el Inglés, Yaguanabo, Cienfuegos, Cuba).

alleni de La Torre, *Cerion:* 1929, Nautilus, **42,** pl. 4, figs. 10-11 [no description] (Antilla [Oriente] Cuba).

alvearia Dillwyn, *Turbo:* 1817, Descriptive Catalogue of Recent Shells, **2,** p. 862 (Santo Domingo and Guadeloupe). [Not recognisable.]

angustalabra Maynard and Clapp, *Strophiops:* 1921, Records, App., **10,** p. 143, pl. 39, figs. 9-10 (fossil, cliffs, west side of Rose Island, opp. Green Key, New Providence, Bahamas).

angustocostata Maynard and Clapp, *Strophiops:* 1921, Records, App., **10,** p. 141 (fossil, Lower Fleming Key [Eleuthera] Bahamas). Is *C. exiguum* Mayn., Clench 1952.

anodonta Dall, *Strophia* (*Eostrophia*): 1890, Trans. Wagner Free Institute of Science, **3,** p. 13, pl. 1, fig. 8c-d (fossil, Oligocene, Ballast Point, Old Tampa Bay, Florida).

antiqua Maynard, *Strophiops:* 1913, Records, App., **5,** p. 183 (fossil, Nassau, New Providence, Bahamas).

antonii Küster, *Pupa:* 1847, Conchylien-Cabinet (2), **1,** pt. 15, p. 92, pl. 10, figs. 7-8 (Berbice [British Guiana]. [Probably Great Inagua, Bahamas.]

apiarium Röding, *Cerion:* 1798, Museum Boltenianum, (2) p. 90, [refers to *Turbo uva* Gmelin].

arangoi Pilsbry and Vanatta, *Cerion iostomum:* 1896, Proc. ANSP, p. 330, pl. 11, fig. 12 (Cienfuegos, Cuba).

arbusta Maynard and Clapp, *Strophiops:* 1921, Records, App., **10,** p. 133, pl. 30, figs. 5-6 (Guana Key, Berry Islands, Bahamas).

argentia Maynard, *Strophiops:* 1913, Records, App., **5,** p. 191 (Three Silver Keys, New Providence, Bahamas).

argntea Maynard and Clapp, *Strophiops:* 1921, Records, App., **10,** p. 138 (Middle Silver Key, New Providence, Bahamas). [Error for *argentia* Maynard].

armouri Clench, *Cerion* (*Strophiops*): 1933, Proc. New England Zool. Club, **13,** p. 96, pl. 1, fig. 4 (South coast of Miraguana Island, Bahamas).

arubanum H. B. Baker, *Cerion uva:* 1914, Occ. Papers, Univ. Michigan, Mus. Zool. no. 152, p. 104, pl. 20 (Baranca Alto, Aruba, Dutch West Indies).

aspera Maynard and Clapp, *Strophiops:* 1920, Records, App., **10,** p. 116, pl. 1, figs. 9-10 (South end of Great Guana Cay [Exuma Group] Bahamas).

aviaria Maynard and Clapp, *Strophiops:* 1921, Records, App., **10,** p. 130, pl. 27, figs. 9-10 (Bird Key, Berry Islands, Bahamas).

avita Maynard, *Strophiops:* 1913, Records, App., **5,** p. 190 (fossil, Silver Key, W. of Nassau Bar, New Providence, Bahamas).

baconi Bartsch, *Cerion* (*Cyelocerion*): 1952, Revista, **9**, p. 1, text fig. 1 (Northwest Point, Little Inagua, Bahama Islands).

balaena Maynard and Clapp, *Strophiops:* 1921, Records, App., **10**, p. 131, pl. 29, figs. 3-4 (Whale Key, Berry Islands, Bahamas).

banesense Clench and Aguayo, *Cerion:* 1949, Torreia, no. 14, p. 7, pl. 1, figs. 13-15 (east side of Bahía de Samá, Banes, Oriente, Cuba).

barbouri Clench, *Cerion* (*Strophiops*): 1933, Proc. New England Zool. Club, **13**, p. 95, pl. 1, fig. 5 (south coast of Miraguana Island, Bahamas).

basistriatum Pilsbry and Vanatta, *Cerion* (*Paracerion*): 1895, Proc. ANSP, p. 206; *ibid.* 1896, p. 335, pl. 11, fig. 28 (Cabo Cruz, Cuba).

bendalli Pilsbry and Vanatta, *Cerion abaeoense:* 1896, Proc. ANSP, p. 332, pl. 11, fig. 13 ([Great] Abaco, Bahamas).

bequaerti de la Torre and Clench, *Cerion aguayoi:* 1932, Nautilus, **45**, p. 91, pl. 6, fig. 8 (dunes at Lueretia lighthouse, near Banes, Cuba).

bermudezi Aguayo and Jaume, *Cerion gundlachi:* 1951, Revista, **8**, p. 4, pl. 2, fig. 9 (Punta Brava, Caibarién, Las Villas, Cuba).

berryense Plate, *Cerion glans:* 1907, Archiv für Rassen-und Gesell. Biologie, **4**, p. 596, pl. 5, fig. c (Great Harbour Cay, Berry Islands, Bahamas).

bidens Beck, *Pupa chrysalis:* 1837, Index Molluscorum, p. 82 [based on Férussac 1832, Histoire Naturelle Général et Particulière des Mollusques, pl. 153, fig. 5. Names such as *bidens, edentula, normalis, major, minor,* etc. were not used by Beck in any sense for categories below a species, either as varieties or subspecies. These were descriptive terms only and were used to indicate minor variations which existed in the material studied, either as specimens or as figures. Unfortunately many of these names have been used in subsequent works as validly introduced names. These should be discarded.]

bidens Röding, *Cerion:* 1798, Museum Boltenianum, p. 9 [based upon *Turbo bidens* Gmelin=*Nenia bidens* Schweigger (Clausiliidae)].

bimarginata Maynard, *Strophia:* 1894, Contributions, **2**, p. 164, fig. 53 (Green Key, east coast of Andros, Bahamas). Is *C. griseum* Mayn., Pilsbry 1902.

biminiensis Henderson and Clapp, *Cerion:* 1913, Nautilus, **27**, p. 64, pl. 4, figs. 9-10 (southern end of North Bimini Cay, Bahama Islands).

bioscai Aguayo and Jaume, *Cerion* (*Paracerion*): 1951, Revista, **8**, p. 14, pl. 1, figs. 11-12 (Punta de Práticos, Nuevitas, Camagüey, Cuba).

blandi Pilsbry and Vanatta, *Cerion:* 1896, Proc. ANSP, p. 334, pl. 11, fig. 7 (Turks Island, Bahamas).

blanesi Clench and Aguayo, *Cerion:* 1951, Revista, **8**, p. 70, pl. 11, fig. 1 (Los Cocos, east side of Bahía de Gibera, Cuba).

bonairensis H. B. Baker, *Cerion uva:* 1914, Occ. Papers, Univ. Michigan, Mus. Zool., no. 152, p. 105, pl. 21 (Porta Spaño, Bonaire, Dutch West Indies).

botrys Röding, *Cerion:* 1798, Museum Boltenianum, p. 90 [based upon Lister, pl. 585, fig. 43 = *Littorina littorea* Linné].

brevispira Pilsbry and Vanatta, *Cerion:* 1895, Proc. ANSP, p. 209 (Turks Island [Bahamas]).

brownei Maynard, *Strophia:* 1889 [1891], Contributions, **1,** p. 196, pl. 16, fig. 4-a (north side of Rum Key, Bahamas).

brunneum Dall, *Cerion* (*Strophiops*): 1905, Smithsonian Misc. Collections, **47,** p. 441, pl. 58, fig. 9 (Governors' Harbor, Eleuthera, Bahamas). Is *C. eximeum* Mayn., Clench 1952.

bryanti Pfeiffer, *Pupa:* 1867, Malakozoologische Blätter, **14,** p. 130 (southern [Great] Inagua, Bahamas).

cabocruzense Pilsbry and de la Torre, *Cerion:* 1943, Nautilus, **57,** p. 34, refers to Manual of Conchology, (2) **14,** p. 278, pl. 46, fig. 21, description and figures only, not the name (i.e. *stritellum* "Guerin" Pilsbry, is *C. cabocruzense* Pilsbry and de la Torre, non *stritellum* "Ferassae" Guerin).

cabrerai Aguayo and Sánchez Roig, *Cerion mumia:* 1953, Memorias, **21,** p. 283, pl. 32, fig. 1 (Cayo Hicacos o Inés de Soto, N.W. de Puerto Esperanza, Pinar del Río, Cuba).

caduca Maynard and Clapp, *Strophiops:* 1921, Records, App., **10,** p. 133, pl. 30, figs. 9-10 (Cabbage Key, Berry Islands, Bahamas).

caerulea Maynard and Clapp, *Strophiops:* 1915, Records, App., **6,** p. 181 (Field north of Fort Charlotte, Nassau, New Providence, Bahamas).

caerulescens Maynard and Clapp, *Strophiops:* 1920, Records, App., **10,** p. 122, pl. 23, fig. 5 (Key north of Key opposite Roseville, Great Exuma, Bahamas).

caicosense Clench, *Cerion* (*Strophiops*): 1937, Proc. New England Zool. Club, **16,** p. 23, pl. 1, fig. 4 (Cockburn Town, South Caicos Island, Caicos Islands, Bahamas).

calcarea Pfeiffer, *Pupa:* 1847, Zeitschrift für Malakozoologie, **4,** p. 83 (locality unknown [Little Inagua, Bahamas-Bland 1875]).

cana Maynard and Clapp, *Strophiops:* 1921, Records, App., **10,** p. 137, pl. 34, figs. 3-4 (Fortune Key, Berry Islands, Bahamas).

canasiense Aguayo and A. de la Torre, *Cerion ceiba:* 1951, Revista, **8,** p. 22, pl. 3, fig. 3 (West of the Boca del Río, Canasi, Matanzas, Cuba).

candida Maynard and Clapp, *Strophiops:* 1921, Records, App., **10,** p. 131, pl. 28, figs. 5-6 (East Marketfish Key, Berry Islands, Bahamas).

canonicum Dall, *Cerion* (*Strophiops*): 1905, Smithsonian Misc. Collections, **47,** p. 439, pl. 48, fig. 13 (Gun Key [Bimini Islands] Bahamas). Is *C. pillsburyi* P. and V., Clench 1942.

capillaris Beck, *Pupa:* 1837, Index Molluscorum, p. 82 [*nomen nudum*].

capraia Maynard and Clapp, *Strophiops:* 1921, Records, App., **10,** p. 131, pl. 28, figs. 7-8 (North Goat Key, Fresh Creek, Andros, Bahamas).

cardenense Aguayo and Sánchez Roig, *Cerion microdon:* 1953, Memorias,

21, p. 285, pl. 32, fig. 7 (El Genovés, Cayos de los Cinco Leguas, Cárdenas, [Matanzas] Cuba).

carlotta Maynard, *Strophia:* 1894, Contributions, **2,** p. 154, fig. 49 (North side of hill, Fort Charlotte, Nassau, New Providence, Bahamas). Is *C. coryi* Mayn., Pilsbry 1902.

carnale Maynard and Clapp, *Strophiops:* 1921, Records, App., **10,** p. 136, pl. 33, figs. 5-6 (West [one mile] of Morgan's Bluff, Andros Island, Bahamas).

caroli Aguayo and A. de la Torre, *Cerion:* 1951, Revista, **8,** p. 20, pl. 3, fig. 2 (Near lighthouse at Punto de Guanos, W. of Punta de Sabanilla, Matanzas, Cuba).

casablancae Bartsch, *Cerion:* 1920, Carnegie Inst., Washington, **14,** pub. no. 282, p. 33, pl. 2; pls. 32-47 (White House region, Andros, Bahamas).

castra Maynard and Clapp, *Strophiops:* 1921, Records, App., **10,** p. 147, pl. 42, figs. 9-10 (field west of Williams St., Nassau, New Providence, Bahamas).

catherwoodianum Wurtz, *Cerion:* 1950, Proc. ANSP, **102,** p. 100, pl. 2, figs. 5-6 (Station 7, Cayo Largo, Banco Jardines, Cuba).

caymanense Pilsbry, *Cerion:* 1902, M. of C., (2) **14,** p. 196, pl. 44, figs. 85-86 (Grand Cayman Island [Cayman Islands]).

ceiba Clench, *Cerion:* 1948, Revista, **6,** p. 49, text figs. 1-3 (north side of Boca del Río Jibacoa, Santa Cruz del Norte, Habana, Cuba).

cera Maynard, *Strophia bimarginata:* 1894, Contributions, **2,** p. 168, fig. 54 (Green Cay, Andros Island, Bahamas). Is *C. griseum* Mayn., Pilsbry 1902.

cervina Maynard and Clapp, *Strophiops:* 1920, Records, App., **10,** p. 121, pl. 22, figs. 8-9 (Refuge Key, east of Normans Pond Key [Exuma Group] Bahamas).

chaparra Aguayo and Sánchez Roig, *Cerion:* 1953, Memorias, **21,** p. 292, pl. 32, fig. 19 (Bahía de Puerto Padre, Oriente, Cuba).

chaplini Wurtz, *Cerion:* 1950, Proc. ANSP, **102,** p. 99, pl. 2, figs. 1-4 (Station 19, Cayo Largo, Banco Jardines, Cuba).

christophei Clench, *Cerion:* 1937, Proc. New England Zool. Club, **16,** p. 24, pl. 1, fig. 2 (Northeast Point (Christoph's Palace) Great Inagua, Bahamas).

chrysalis "Férussac" Beck *Pupa:* 1837, Index Molluscorum, p. 82.

chrysaloides Plate, *Cerion:* 1907, Archiv für Rassen- und Gesell. Biologie, **4,** p. 597, pl. 5, fig. a (Eight Mile Rock, Great Bahama Island, Bahamas).

cinerea Maynard, *Strophia:* 1894, Contributions, **2,** p. 119, fig. 35 (Middle Bay, Hog Island, New Providence, Bahamas). Is *C. varium* Bonnet, Pilsbry 1902.

cinerea-vara Maynard, *Strophiops:* 1913, Records, App., **5,** p. 185 (E. end of Hog Island, New Providence, Bahamas). [Corrected to *varia, ibid.* p. 199.]

circumscriptum Aguayo and Jaume, *Cerion:* 1951, Revista, **8,** p. 12, pl. 1,

fig. 10 (Guanalito, Cayo Romano, northern Camagüey, Cuba). Is *C. sanzi* P. and V. See Notes, this report.

cisnerosi Clench and Aguayo, *Cerion:* 1951, Revista, **8.** p. 72, pl. 11, figs. 3-4 (Playa Morrillo, 11 kilometers west of Bahía Honda, Pinar del Río, Cuba).

clappii Maynard, *Strophiops:* 1913, Records, App., **5.** p. 198 (Salina north of Current Settlement, Eleuthera, Bahamas). Is *C. laeve* Plate, Clench 1952.

clara Maynard, *Strophiops:* 1924, Catalogue, Supp., p. 4 (Church, East Bay St. to Fox Hill, Nassau, New Providence, Bahamas).

clathrata Humphrey, *Pupa:* 1797, Museum Calonnianum, p. 64. [Names of *Cerion*, i.e. *Pupa*, appearing in this sales catalogue are without description, figure or reference. In addition, it has also been ruled (Opinion 51) as not acceptable as a source of names.]

cliffordi Clench, *Cerion* (*Strophiops*) *martensi:* 1933, Proc. New England Zool. Club, **13.** p. 91, pl. 1, fig 10 (Landrail Point, Crooked Island, Bahamas).

coarctata Beck, *Pupa uva:* 1837, Index Molluscorum, p. 82, [see note under *bidens* Beck].

cobarrubia Aguayo and Jaume, *Cerion:* 1951, Revista, **8.** p. 8, pl. 1, fig. 2 (Punta Cobarrubia, between Manatí and Puerto Padre, Oriente, Cuba).

Cochlodon Sowerby: 1825, Catalogue of the Shells in the Collection of the Earl of Tankerville, p. 40, London.

Cochlodonta Férussac: 1821, Prodrome, Tableau Systematique des Limaçons, Paris, p. 24 [28] and p. 58.

columbiana Maynard and Clapp, *Strophiops:* 1921, Records, App., **10.** p. 136, pl. 33, figs. 3-4 (Pigeon Key, Staniard Creek, Andros, Bahamas).

columbinus Sánchez Roig, *Cerion:* 1951, Revista, **7.** p. 117, pl. 18, fig. 8 (North coast of Cayo Paloma, north of Cayo Romano, Camagüey, Cuba).

columna Pilsbry and Vanatta, *Cerion* (*Maynardia*): 1895, Proc. ANSP, **47.** p. 207 (Turtle Cove, Great Inagua, Bahama Islands).

comes Pilsbry and Vanatta, *Cerion regina:* 1895, Proc. ANSP, **47.** p. 208 (Turks Island [Bahamas]).

concina Maynard, *Strophiops:* 1924, Catalogue, Supp., p. 4, (fossil, crab holes, St. James Corner, Nassau, New Providence, Bahamas).

confusa Maynard and Clapp, *Strophiops:* 1921, Records, App., **10.** p. 130, pl. 28, figs. 1-2; p. 136, pl. 34, figs. 1-2 (Little Harbor Key, Berry Islands, Bahama Islands). [This species was described twice as new; the descriptions and figures vary a little.]

constrictum Aguayo and Jaume, *Cerion marielinum:* 1953, Memorias, **21.** p. 275, pl. 31, fig. 11 (La Puntilla, Bahía del Mariel, Pinar del Río, Cuba).

conus Beck, *Pupa:* 1837, Index Molluscorum, p. 82 [*nomen nudum*].

copia Maynard, *Strophia:* 1889, Contributions, **1.** p. 22, pl. 1, figs. 1-2, 7-12; pl. 2, figs. 8-8b (West end of Cayman Brac and north side of Little Cayman). Is *C. pannosum* Mayn., Pilsbry 1901.

copiosa Pilsbry, *Strophia:* 1901, M of C, (2) **14.** p. 187 (Cayman Brac, Cayman Islands). [A suggested name to replace *S. copia* Maynard. It has no value.]

coryi Maynard, *Strophia:* 1894, Contributions, **2.** p. 129, fig. 39 (extreme west end of New Providence, Bahamas).

costata Beck, *Pupa decumana:* 1837, Index Molluscorum, p. 82 [see note under *bidens* Beck].

costulata Beck, *Pupa decumana:* 1837, Index Molluscorum, p. 82 [see note under *bidens* Beck].

coutini Sánchez Roig, *Cerion:* 1951, Revista, **7.** p. 119, pl. 19, fig. 6 (Taco Bay, Baracoa, Oriente, Cuba).

crassa Maynard and Clapp, *Strophiops:* 1920, Records, App., **10.** p. 123, pl. 21, figs. 9-10 (East Hill, Little Norman Key, [Exuma Group] Bahamas).

crassalabra Maynard and Clapp, *Strophiops:* 1921, Records, App., **10.** p. 143, pl. 39, figs. 7-8 (fossil, in cliffs, E. side of Rose Island [New Providence] Bahamas).

crassicostata "Maynard" Pilsbry, *Cerion:* 1896, Proc. ANSP, p. 323 [listed in the synonymy of *Cerion griseum* Maynard] (Andros, Bahamas).

crassilabris "Shuttleworth" Sowerby, *Pupa:* 1875, Conchologia Iconica, **20.** p. 12, fig. 14; Pilsbry 1943, Nautilus, **57.** p. 34 (India [Puerto Rico]). Is *Cerion striatellum* Guerin, Pilsbry 1943.

crassiusculum "Torre" Pilsbry and Vanatta, *Cerion:* 1898 [1899], Proc. ANSP, p. 477, text figs. 7-8 (Cayo Juin, Baracoa, Cuba).

crescentia Maynard and Clapp, *Strophiops:* 1921, Records, App., **10.** p. 136, pl. 33, figs. 9-10 (Calabash Key, N. Andros, Bahamas).

cumingianum Pfeiffer, *Pupa:* 1852 [1854] Proc. Zool. Soc. London, p. 68, (Locality unknown).

curtissii Maynard, *Strophia:* 1894, Contributions, **2.** p. 107, fig. 33 (Cemetery between Waterloo and Nassau, New Providence, Bahamas). Is *C. carium* Bonnet, Pilsbry 1902.

cuspidata Aguayo and Sánchez Roig, *Cerion circumscriptum romanoensis* form: 1953, Memorias, **21.** p. 290 [New name for *Cerion mumia gigantea* Sánchez Roig, not Maynard 1894].

Cyclocerion Bartsch: 1952, Revista, **9.** p. 1 (type species, *Cerion* (*Cyclocerion*) *baconi* Bartsch, monotypic). Is a synonym of *Strophiops* Dall.

cyclostoma Sowerby, *Pupa:* 1875, Conchologica Iconica, **20.** pl. 19, fig. 179 (Cuba); non *cyclostomum* Küster.

cyclostomum Küster, *Pupa:* 1841, Conchylien-Cabinet, **1.** pt. 15, p. 6, pl. 1, figs. 5-6 (locality unknown [Cayo Francés, Cuba, Arango]).

cyclura Maynard and Clapp, *Strophiops:* 1920, Records, App., **10.** p. 119, pl. 3, figs. 3-5 (Bitter Guana Key [Exuma Group] Bahamas).

cylindriata Maynard and Clapp, *Strophiops:* 1920, Records, App., **10.** p. 123, pl. 23, figs. 8-9 (first key north of Leward Stocking [Lee Stocking] Key [Exuma Group] Bahamas).

cylindrica Maynard, *Strophia:* 1896, Contributions, **3**, p. 34, pl. 7, figs. 3 4 (Matthewstown, Inagua, Bahamas). Is *C. rubicundum* Menke, Pilsbry 1902.

dallii Maynard, *Strophia:* 1889, Contributions, **1**, p. 128, pl. 16, fig. 1b (Inagua, Bahamas).

deani M. Smith, *Cerion:* 1943, Nautilus, **57**, p. 59, pl. 7, fig. 7 (The Current, south tip of Abaco ["The Current" northern Eleuthera] Bahamas). Is *C. lacve* Plate, Clench 1952.

decumana "Férussac" Pfeiffer, *Pupa:* Monographia Heliceorum Viventium, **2**, p. 320 (St. Thomas; Cuba?) [Castle Island, Bahamas]. Is *C. regium* Benson, Pilsbry 1902.

decumanus Férussac, *Cochlodonta:* 1821, Tableaux Systematiques des animaux Mollusques, p. 59 [or 63] (locality unknown) [*Nomen nudum*].

degeneri Clench, *Cerion:* 1948, Revista, **6**, p. 50, text figs. 4-6 (Fleeming Point, New Providence, Bahamas).

degenis Maynard and Clapp, *Strophiops:* 1920, Records, App., **10**, p. 120, pl. 4, figs. 6-7 (Harvest [Harvey's] Key [Exuma Group] Bahamas).

delicata Maynard, *Strophiops:* 1913, Records, App., **5**, p. 190 (South Key off Sound Point, New Providence, Bahamas).

desculptum Pilsbry and Vanatta, *Cerion:* 1896, Proc. ANSP, p. 328, pl. 11, fig. 1 (Curaçoa [Dutch West Indies]).

detrita "Shuttleworth" Pfeiffer, *Pupa:* 1854, Malakozoologische Blätter, **1**, p. 205, pl. 3, figs. 9-10 (Florida). Is *C. incanum* Binney, Pilsbry 1902.

devereuxi Maynard and Clapp, *Strophiops:* 1915, Records, App., **6**, p. 181 (Devereux Estate, west end of New Providence, Bahamas).

diablensis H. B. Baker, *Cerion uva:* 1914, Occ. Papers, Mus. Zool., Univ. Michigan, no. 152, p. 100, pl. 18, fig. A2 (Ronde Klip, Curaçao, Dutch West Indies).

Diacerion Dall: 1894, Bull. Mus. Comp. Zool., **25**, p. 122. Type species, *Strophia dallii* Maynard.

dickersoni Richards, *Cerion:* 1935, Jour. of Paleont., **9**, p. 257, pl. 25, fig. 24 [not fig. 25 as given in the text] (Pleistocene. Sand in sea cave near road to Monserrat, Matanzas, Cuba).

dickersoni Torre and Bermudez, *Cerion:* 1951, Revista, **8**, p. 8 [MS. name introduced as a synonym of *C. royi* Aguayo and Jaume, *non C. dickersoni* Richards].

dimidiata Pfeiffer, *Pupa:* 1847, Zeitschrift für Malakozoologie, **4**, p. 16 (Cuba).

dimidiatia "Pfeiffer" Maynard, *Strophia:* 1896, Contributions, **3**, p. 30 [error for *dimidiata* Pfeiffer].

disforme Clench and Aguayo, *Cerion:* 1946, Revista, **4**, p. 85, text figs. 1-6 (Cercanías de Punta Manolito, Peninsula del Ramón, Antilla, Oriente, Cuba).

dissimila Maynard and Clapp, *Strophiops:* 1920, Records, App., **10**, p. 119, pl. 24, figs. 8-9 (East Cistern Key [Exuma Group] Bahamas).

djerimensis H. B. Baker, *Cerion uva knipensis:* 1914, Occ. Papers, Mus. Zool., Univ. Michigan, no. 152, p. 103, pl. 19, fig. A1 (shore cliffs near Playa Djerimi, Curaçao, Dutch West Indies).

dominicanum Clench and Aguayo, *Cerion marielinum:* 1951, Revista, **8** p. 69, pl. 10, figs. 1-3 (east side of Boca del Río Dominica, about 10 miles west of Mariel, Cuba).

dorotheae Aguayo and Jaume, *Cerion:* 1951, Revista, **8**, p. 10, pl. 1, figs. 5-7 (Punta de Cayo Cocos, northern Camagüey, Cuba).

drupium Dall, *Cerion* (*Strophiops*) *eleutherae:* 1905, [in] The Bahama Islands, ed. by G. B. Shattuck, Baltimore, p. 35 (fossil, Station 6, above Glass Window, Eleuthera, Bahamas). Is *C. eleutherae* P. and V., Clench 1952.

duplodon Pilsbry and Vanatta, *Cerion:* 1896, Proc. ANSP, p. 337, pl. 11, fig. 25 (Bahamas).

ebriolum Aguayo and Jaume, *Cerion:* 1951, Revista, **8**, p. 6, pl. 2, fig. 6 (Cayo Borracho, east of Cayo Francés, Caibarién, Las Villas, Cuba).

eburnia Maynard, *Strophia:* 1894, Contributions, **2**, p. 144, fig. 45 (U Key, [Exuma Group] Bahamas).

edentula Beck, *Pupa chrysalis:* 1837, Index Molluscorum, p. 82 [see note under *bidens* Beck].

edentula Beck, *Pupa uva:* 1837, Index Molluscorum, p. 82 [see note under *bidens* Beck].

elegans Beck, *Pupa:* 1837, Index Molluscorum, p. 82 [*nomen nudum*].

elegantissima Maynard and Clapp, *Multicostata:* 1920, Records, App., **10**, p. 126, pl. 25, figs. 1-2 (Norman's Pond Key [Exuma Group] Bahamas).

eleutherae Pilsbry and Vanatta, *Cerion:* 1896, Proc. ANSP, p. 333, pl. 11, figs. 19-20 (Eleuthera, Bahamas).

elongata Maynard, *Strophia:* 1894, Contributions, **2**, p. 148, fig. 46 (small key 1 mile north of U Key [Exuma Group] Bahamas). Is *C. eburneum* Maynard, Pilsbry 1902.

Eostrophia Dall: 1890, Trans. Wagner Free Inst. Sci., Philadelphia, **3**, p. 12 [type species, *Strophia* (*Eostrophia*) *exodonta* Dall, here selected.]

eratica Maynard and Clapp, *Strophiops:* 1921, Records, App., **10**, p. 147, pl. 42, figs. 7-8 (Fox Hill Village, New Providence, Bahamas).

eucosmium Pilsbry and Vanatta, *Cerion regina:* 1895, Proc. ANSP, p. 208, (no locality given [Turks Island]). Is *C. regina* Pilsbry and Vanatta, here considered a synonym.

eurystoma Maynard, *Strophia:* 1896, Contributions, **3**, p. 7, pl. 2, figs. 3-4 (Havana, Cuba). Is *C. chrysalis* Fér., Pilsbry 1902.

evolva Maynard, *Strophia pilsbryi:* 1894, Contributions, **2**, p. 173, fig. 57 (west end of Goat Key, Middle Bight, Andros, Bahamas). Is *C. griseum* Mayn., Pilsbry 1902.

exasperata Maynard and Clapp, *Strophiops:* 1920, Records, App., **10**, p. 123, pl. 23, figs. 1-2 (Key east of Anna's Tract, Great Exuma, Bahamas).

exigua Maynard, *Strophiops:* 1913, Records, App., **5**, p. 196 (southern portion of Fleming Key [near northern Eleuthera] Bahamas).

eximea Maynard, *Strophia:* 1894, Contributions, **2**, p. 177, fig. 59 (Cat Island, Bahamas).

eximium "Maynard" Pilsbry, *Cerion:* 1902, M. of C., (2) **14**, p. 265, pl. 38, figs. 76-78 [error for *eximeum*] (Cat Island [Bahamas]).

exorta Maynard and Clapp, *Strophiops:* 1920, Records, App., **10**, p. 122, pl. 24, figs. 4-5 (Refuge Key, [Exuma Group] Bahamas).

extensa Maynard, *Strophiops:* 1924, Catalogue Suppl., p. 2, (Baptist Chapel, East Nassau, New Providence, Bahamas).

extranea Maynard, *Strophiops:* 1924, Catalogue, Suppl., p. 2 (Roseville Key, Exuma Group, Bahamas).

extrema Maynard and Clapp, *Strophiops:* 1920, Records, App., **10**, p. 118, pl. 2, figs. 10-11 (south end of Great Guana Key [Exuma Group] Bahamas).

exumense Plate, *Cerion:* 1907, Archiv für Rassen- und Gesell. Biol., **4**, p. 607, pl. 3, figs. b-e-d (two unnamed islands between Shroud Cay and Conch Cut and Stocking Island, opposite Georgetown, Great Exuma, Bahamas).

fairchildi Clench, *Cerion (Strophiops):* 1933, Proc. New England Zool. Club, **13**, p. 97, pl. 1, fig. 6 (Conception Island, Bahamas).

fasciata Binney, *Pupa:* 1859, The Terrestrial Air-Breathing Mollusks of the United States, **4**, pp. 152, 205, pl. 79, fig. 17 (Key Biscayne, Florida). Is *C. incanum* Binney, Pilsbry 1902.

fasciata "Maynard" Pilsbry, *Cerion:* 1902, M. of C., (2) **14**, p. 215 (Key Vaca, Florida). [This has been quoted by Pilsbry as named by Maynard but he was only using Binney's name for this identical form, 1889, Contributions, **1**, p. 133.]

fastigata Maynard, *Strophia:* 1896, Contributions, **3**, p. 6, pl. 2, figs. 1-2 (Matanzas [Havana] Cuba). Is *C. chrysalis* Fér., Pilsbry 1902.

faxoni Maynard, *Strophia:* 1896, Contributions, **3**, p. 32, pl. 7, figs. 1-2 (Cuba). Is *C. johnsoni* Pilsbry and Vanatta, Pilsbry 1902.

felis Pilsbry and Vanatta, *Cerion (Maynardia):* 1895, Proc. ANSP, p. 206 (Cat Island, Bahamas).

feltoni Sánchez Roig, *Cerion:* 1951, Revista, **7**, p. 119, pl. 19, fig. 3 (Felton, Mayarí, Cuba).

feriai Clench and Aguayo, *Cerion vulneratum:* 1953, Torreia, no. 18, p. 3, text fig. 6 (Cayo Largo o de los Muertos, Bahía o Puerto Naranjo, Oriente, Cuba).

feriai de la Torre, *Cerion:* 1953, Torreia, no. 18, p. 3 [MS. name in the synonymy of *Cerion vulneratum feriai* Clench and Aguayo].

fernandina Clench, *Cerion (Strophiops):* 1937, Nautilus, **51**, p. 21, pl. 3, fig. 5 (Millers, 8 miles S.E. of Simms, Long Island, Bahamas).

ferruginea Maynard, *Strophia:* 1896, Contributions, **3**, p. 19, pl. 4, figs. 5-6 (Jeremie, Haiti).

festiva Maynard, *Strophia:* Contributions, **1.** p. 17, pl. 2, fig. 5a-c (Little Cayman Island [Cayman Islands]). Is *C. levigatum* Mayn., Pilsbry 1901.

fincastlei Maynard and Clapp, *Strophiops:* 1921, Records, App., **10.** p. 148, pl. 44, figs. 5-6 (Fort Fincastle, West Nassau, New Providence, Bahamas).

fitzgeraldi Maynard and Clapp, *Strophiops:* 1921, Records, App., **10.** p. 127, pl. 25, figs. 6-7 (northern end of Little Exuma Key [Exuma Group] Bahamas).

flacida Maynard and Clapp, *Strophiops:* 1921, Records, App., **10.** p. 152, pl. 48, figs. 3-4 (fossil, in rocks above Queen's Staircase, Nassau, New Providence, Bahamas).

flamea Maynard and Clapp, *Strophiops:* 1921, Records, App., **10.** p. 128, pl. 25, figs. 8-9 (Southwest Point, Great Exuma, Bahamas).

floridanum Dall, *Strophia anodonta:* 1890, Trans. Wagner Free Inst. Sci., Philadelphia, **3.** p. 13, pl. 1, fig. 6 (Oligocene, Ballast Point, Florida).

fordii Pilsbry and Vanatta, *Cerion:* 1897, Proc. ANSP, **49.** p. 365, text figs. 1-2 (Bahamas [Cat Island]).

fragilis Maynard and Clapp, *Strophiops:* 1921, Records, App., **10.** p. 128, pl. 26, figs. 3-4 (second westernmost Brigadier Key [Brigantine] [Gt. Exuma] Bahamas).

fraternum Pilsbry, *Cerion eximium:* 1902, M. of C., (2) **14.** p. 265, pl. 38, figs. 79-80 (San Salvador [Cat Island, Bahamas]).

fruticosa Maynard and Clapp, *Strophiops:* 1920, Records, App., **10.** p. 125, pl. 20, figs. 3-4 (Bush Key [Exuma Group] Bahamas).

fulminea Maynard and Clapp, *Strophiops:* 1915, Records, App., **6.** p. 182 (east of Fort Winton, New Providence, Bahamas).

fulvia Maynard and Clapp, *Strophiops:* 1920. Records, App., **10.** p. 121, pl. 4, figs. 4-5 (Pipe Key [=Fowl Key, Exuma Group] Bahamas).

fusca Maynard, *Strophia:* 1889, Contributions, **1.** p. 77, pl. 7, fig. 19a; text figs. 12a-b (west end of Little Cayman, [Cayman Islands]). Is *C. pannosum* Mayn., Pilsbry 1901.

fuscata Binney, *Strophia:* 1885, Bull. U. S. Nat. Mus., **28.** p. 484 [error for *fasciata* Binney].

fusus Bruguière, *Bulimus:* 1792, Encyclopédie Méthodique (Vers), **1.** p. 348 (Santo Domingo and Guadaloupe) [not recognisable].

genitiva Maynard and Clapp, *Strophiops:* 1920, Records, App., **10.** p. 124, pl. 22, figs. 3-4 (fossil, south end of Ship Channel Key, [Exuma Group] Bahamas).

geophilus Clench and Aguago, *Cerion:* 1949, Torreia, no. 14, p. 5, pl. 1, figs. 7-12 (Punta de Piedra, Banes, Cuba).

gigantea Sánchez Roig, *Cerion mumia:* 1951, Revista, **7.** p. 111, pl. 18, fig. 5 (Cayo Romano, N. Lat. 22° 24′; W. Long. 78° 6′, Cuba). [Is *Cerion cuspidata* Aguayo and Sánchez Roig.]

gigantea Maynard and Clapp, *Strophiops:* 1921, Records, App., **10.** p. 152,

pl. 47, figs. 9-10 (wall, Village Road, Sherley St., Nassau, New Providence, Bahamas). [Is *S. ajax* Maynard, *non S. gigantea* Maynard, 1894.]

gigantea Maynard, *Strophia grayi:* 1894, Contributions, **2,** p. 141, fig. 44A (middle part of Highburn Key [Exuma Group] Bahamas).

glaber Maynard, *Strophia:* 1889, Contributions, **1,** p. 25, pl. 2, figs. 10-10b (west end of Cayman Brac, Cayman Islands). Is *C. pannosum* Mayn., Pilsbry 1901.

glans Küster, *Pupa:* 1844, Conchylien-Cabinet, (2) **1,** pt. 15, p. 74, pl. 11, figs. 1-2 (locality unknown [New Providence and Eleuthera, Bahamas]).

gracila Maynard, *Strophiops:* 1924, Catalogue, Suppl., p. 3, (Soldiers Road, 1½ miles from south shore, Nassau, New Providence, Bahamas).

grayi Maynard, *Strophia:* 1894, Contributions, **2,** p. 138, fig. 42, (north end of Highburn Key [Exuma Group] Bahamas).

greenwayi Clench, *Cerion* (*Strophiops*): 1934, Proc. Boston Soc. Nat. Hist., **40,** p. 206, pl. 2, fig. H (Black Booby Cay (West Booby) Atwoods or Samana Group, Bahama Islands).

grillocnsis Sánchez Roig, *Cerion:* 1951, Revista, **7,** p. 117, pl. 19, fig. 2 (Cayo Grillo, south coast of Isla Guajaba, [Camagüey] Cuba).

grisea Maynard, *Strophia glans:* 1894, Contributions, **2,** p. 159, fig. 56, (1 mile north of Fresh Creek, Andros Island, Bahamas).

gruneri Pfeiffer, *Pupa:* 1847, Zeitschrift für Malakozoologie, **4,** p. 15 (locality unknown).

guajabaense Sánchez Roig, *Cerion:* 1951, Revista, **7,** p. 114, pl. 18, fig. 6 (Cayo Grillo, north coast of Isla de Guajaba [Camagüey] Cuba). Is *C. sanzi* Pilsbry and Vanatta. See notes, this report.

gubernatoria Crosse, *Pupa:* 1869, Jour. de Conch., **17,** p. 186; *ibid.* 1870, **18,** p. 105, pl. 2, fig. 4 (New Providence, Bahamas).

guillermi de la Torre, *Cerion mimiola:* 1954, Revista, **9,** p. 40, pl. 15, fig. 2 (Playa de Bueyvaquita, Matanzas, Cuba).

gundlachi Pfeiffer, *Pupa:* 1852, Zeitschrift für Malakozoologie, **9,** p. 175, (Punta de San Juan de los Perros [Camagüey] Cuba).

harringtoni Aguayo and Sánchez Roig, *Cerion paucicostatum:* 1953, Memorias, **21,** p. 292, pl. 32, fig. 18 (Cueva de los Indios, La Patana, Maisi, Oriente, Cuba).

hart-bennetii Maynard and Clapp, *Strophiops:* Records, App., **10,** p. 146, pl. 42, figs. 3-4 (Potter's Key, New Providence, Bahamas).

hatoensis H. B. Baker, *Cerion uva:* 1914, Occ. Papers, Mus. Zool., Univ. Michigan, no. 152, p. 100, pl. 18, fig. F6 (Seroe Spelonk, near Landhuis Hato, Curaçao, Dutch West Indies).

hedwigiae Plate, *Cerion:* 1907, Archiv für Rassen- und Gesell. Biol., **4,** p. 605, pl. 3, fig. a (Ship Channel Cay, northern end of Exuma Sound, Bahama Islands).

helena Maynard, *Strophiops:* 1914, Records, App., **6,** p. 177 (directly south of Fresh Creek, Andros, Bahamas).

hernandezi Aguayo and Sánchez Roig, *Cerion pineria:* 1953, Memorias, **21**, p. 295, pl. 32, fig. 20 (Cayo Real, Cayos de San Felipe, Pinar del Río, [south coast] Cuba).

herrerai Aguayo and Jaume, *Cerion vulneratum?:* 1951, Revista, **8**, p. 3, pl. 2, figs. 4-5 (Cayo Santa Maria, Caibarién, Las Villas, Cuba).

hessei Clench and Aguayo, *Cerion:* 1949, Torreia, no. 14, p. 8, pl. 1, figs. 19-22 (Balcón de las Damas, Guarda la Vaca, Banes, Cuba).

hesternia Maynard and Clapp, *Strophiops:* 1915, Records, App., **6**, p. 180 (west end of Booby Rock [16 miles NE of New Providence] Bahamas).

heterodon Pilsbry, *Cerion rubicundum:* 1902, M. of C., (2) **14**, p. 275, pl. 45, figs. 96-98 (Inagua [Bahamas]).

hologlyptum Pilsbry, *Cerion sagraianum:* 1902, M. of C., (2) **14**, p. 216, pl. 30, fig. 83 (Cayo Blanco, near Cárdenas, Cuba).

hondana Pilsbry, *Cerion mumia:* 1902, M. of C., (2) **14**, p. 299, (Bahía Honda, Cuba).

hughesi Clench, *Cerion:* 1952, Revista, **8**, p. 107, pl. 15, figs. 1-3 (Sandy Point, Savannah Sound, Eleuthera Island, Bahamas).

humberti Clench and Aguayo, *Cerion:* 1949, Torreia, no. 14, p. 4, pl. 1, figs. 16-18 (Ensenada de Júcaro, Bahia de Banes, Banes, Cuba).

huntingtoni Clench, *Cerion:* 1938, Bull. Mus. Comp. Zool., **80**, p. 526, pl. 3, figs. 1 3 (Columbus Point, SE tip of Cat Island, Bahamas).

hyattii Maynard, *Strophiops:* 1913, Records, App., **5**, p. 194 (Bar Bay Settlement, Current Island, [Eleuthera Island] Bahamas).

hyperlissum Pilsbry and Vanatta, *Cerion:* 1896, Proc. ANSP, p. 330, pl. 11, fig. 10 (Cuba).

ianthina Maynard, *Strophia:* 1889, Contributions, **1**, p. 69, pl. 2, figs. 13-13a (south shore of Inagua, 25 miles from Matthewstown, Bahamas). Is *C. rubicundum* Menke, Pilsbry 1902.

ignota Maynard, *Strophia eurystoma:* 1896, Contributions, **3**, p. 9 (Havana, Cuba). Is *C. chrysalis* Fér., Pilsbry 1902.

imperfecta Maynard and Clapp, *Strophiops:* 1920, Records, App., **10**, p. 118, pl. 3, figs. 1-2 (south end of Great Guana Key [Exuma Group] Bahamas).

inaguense Clench, *Cerion* (*Diacerion*): 1933, Proc. New England Zool. Club, **13**, p. 98, pl. 1, fig. 9 (Northwest Point, Great Inagua Island, Bahamas).

incana Binney, *Pupa:* 1851, The Terrestrial Air-Breathing Mollusks of the United States, **1**, p. 109 (*nomen nudum*); *ibid.*, 1852, **2**, p. 316 (as *P. maritima* Pfr.); *ibid.*, 1852, **3**, pl. 68, figs. 1-4 (Key West, Florida).

incanoides Pilsbry and Vanatta, *Cerion* (*Maynardia*): 1895, Proc. ANSP, p. 209 (Turk's Island [Bahamas]).

incisum Dall, *Cerion oweni:* 1905, Smithsonian Misc. Collect., **47**, p. 443, pl. 58, fig. 10 (Stranger Cay, NW of Little Abaco, Bahamas). Is *C. bendalli* P. and V., Clench 1938a.

inconspicuum Dall, *Cerion (Strophiops)*: 1905, Smithsonian Misc. Collect., **47**, p. 439, pl. 58, fig. 2 (Watling Island, Bahamas).

inconstans Maynard and Clapp, *Strophiops:* 1920, Records, App., **10**, p. 119, pl. 3, figs. 7-8 (Bird Key [Exuma Group] Bahamas).

inconsueta Maynard, *Strophiops:* 1913, Records, App., **5**, p. 193 (south portion of Great Pimlico Island [Eleuthera] Bahamas).

incrassata Sowerby, *Pupa:* 1876, Conchologica Iconica, **20**, pl. 1, fig. 6 (Cuba).

indianorum Clench, *Cerion paucicostatum:* 1934, Proc. Boston Soc. Nat. Hist., **40**, p. 210, pl. 2, fig. F (Wemyss Bight, Eleuthera Island, Bahamas).

inexpecta Maynard and Clapp, *Strophiops:* 1921, Records, App., **10**, p. 127, pl. 25, figs. 3-4 (fossil, next to westernmost Brigadier [Brigantine] Key [Exuma Group] Bahamas).

infanda "Shuttleworth" Poey, *Pupa:* 1858, Memorias sobre la Historia Natural de la Isla de Cuba, Habana, **2**, pp. 29, 60 (no locality given [Punta Gorda, Matanzas, Cuba] (Arango)).

infandulum Aguayo and A. de la Torre, *Cerion:* 1951, Revista, **8**, p. 19, pl. 3, fig. 1 (Punta de Sabanilla, north of Matanzas, Cuba).

inflata Maynard, *Strophia:* 1889, Contributions, **1**, p. 126, pl. 7, figs. 21-a; 30 a-b (Salena Point, Acklin Island, Bahamas).

inornata Maynard and Clapp, *Strophiops:* 1920, Records, App., **10**, p. 126, pl. 3, figs. 11-13 (Bell Key [Exuma Group] Bahamas).

inquita Maynard and Clapp, *Strophiops:* 1920, Records, App., **10**, p. 121, pl. 4, figs. 2-3 (Fowl Key, [Exuma Group] Bahamas).

intentata Maynard and Clapp, *Strophiops:* 1920, Records, App., **10**, p. 118, pl. 2, figs. 6-7 (south end of Great Guana Key [Exuma Group] Bahamas). Is *C. processum* M. and C., Clench and Aguayo 1952.

interealaria Maynard and Clapp, *Strophiops:* 1921, Records, App., **10**, p. 129, pl. 26, figs. 9-10 (fossil, Goat Key, Great Harbor Key, Berry Islands, Bahamas).

intermedia Maynard, *Strophia:* 1889, Contributions, **1**, p. 13, pl. 2, figs. 3-3b (south side of Little Cayman and south side of Cayman Brac [Cayman Islands]). Is *C. pannosum* Mayn., Pilsbry 1901.

iostoma Pfeiffer, *Pupa:* 1854, Malakozoologische Blätter, **1**, p. 204 (south coast of Cuba [Cienfuegos] (Pilsbry)).

irregulare Plate, *Cerion glans:* 1907, Archiv für Rassen- und Gesell. Biologie, **4**, p. 594, pl. 4, figs. a and c (Nicholstown, north end of Andros, Bahamas).

jaucoense Aguayo and Sánchez Roig, *Cerion tenuilabre:* 1953, Memorias, **21**, p. 293, pl. 32, fig. 16 (Jauco, Baracoa, Oriente, Cuba).

jaumei Clench and Aguayo, *Cerion peracutum:* 1953, Torreia, no. 18, p. 2, text fig. 3 (La Jijira, between Boca de Jaruco and Santa Cruz del Norte, Habana, Cuba).

jenneyi Maynard and Clapp, *Strophiops:* 1921, Records, App., **10**, p. 134, pl. 31, figs. 9-10 (Anderson's Key [Berry Islands] Bahamas).

johnsoni Pilsbry and Vanatta, *Cerion* (*Maynardia*): 1895, Proc. ANSP, p. 207 (Locality unknown [Mariel, Pinar del Río, Cuba] (Clench)).

joscphi Clench and Aguayo, *Cerion:* 1949, Torreia, no. 14, p. 6, pl. 1, figs. 23-25 (Playa de Uvita, oeste de Caletones, Gibara, Cuba).

josephinae Clench, *Cerion* (*Strophiops*): 1935, Nautilus, **49**, p. 49, pl. 3, figs. 1, 4 (Tate's Bay, SE Long Island, Bahamas).

juliae Clench, *Cerion* (*Strophiops*): 1936, Nautilus, **49**, p. 112, pl. 8, fig. 6, (Great Ragged Cay, Ragged Island Group, Bahamas).

knipensis H. B. Baker, *Cerion uva:* 1914, Occ. Papers, Mus. Zool., Univ. Michigan, no. 152, p. 102, pl. 19 (valley between Seroes Palomba and Bana Hoendoe, Curaçao, Dutch West Indies).

kralendijki H. B. Baker, *Cerion uva bonairensis:* 1914, Occ. Paper, Mus. Zool., Univ. Michigan, no. 152, p. 106, pl. 21, fig. A2 (south of Kralendijk, Bonaire, Dutch West Indies).

kusteri Pfeiffer, *Pupa:* 1852 [1854] Proc. Zool. Soc. London, p. 69; Küster 1855, Conchylien-Cabinet, **1**, pt. 15, p. 165, pl. 20, figs. 3-6 (locality unknown [Cuba]).

laeunorum Dall, *Cerion* (*Strophiops*) *inconspicuum:* 1905, Smithsonian Misc. Collect., **47**, p. 439, pl. 58, fig. 4 (shores of lagoon, Watling Island, Bahamas).

laeve Plate, *Cerion:* 1907, Archiv für Rassen- und Gesell. Biologie, **4**, p. 601, pl. 1, fig. 9 (Current Harbour, Eleuthera, Bahamas).

larga Maynard, *Strophiops:* 1913, Records, App., **5**, p. 184 (Rose Island, opposite Green Key, New Providence, Bahamas).

latilabris Pfeiffer, *Pupa:* 1855, Malakozoologische Blätter, **2**, p. 103, pl. 5, fig. 3 (Blessing, St. Croix [Virgin Islands]). Is *C. rude* Pfr., Pilsbry 1902.

latisinus Pilsbry and Black, *Cerion:* 1930, Proc. ANSP, **82**, p. 292, pl. 22, fig. 9a-d (Wide Opening, Andros, Bahamas).

latonia Maynard and Clapp, *Strophiops:* 1921, Records, App., **10**, p. 147, pl. 43, figs. 7-8 (St. Pauls Quarry, Sherley St., Nassau, New Providence, Bahamas).

laureani Clench and Aguayo, *Cerion:* 1951, Revista, **8**, p. 74, pl. 11, figs. 7-8 (Cabo Corrientes, Peninsula de Guanahacabibes, south Pinar del Río, Cuba).

lembeyei "Torre" Aguayo and Sánchez Roig, *Cerion:* 1953, Memorias, **21**, p. 293 (in the synonymy of *Cerion sanctaeruzense poeyi* Ag. and S. R.).

lenticularia Maynard and Clapp, *Strophiops:* 1921, Records, App., **10**, p. 135, pl. 32, figs. 9-10 (Staniard Creek, Andros Island, Bahamas).

lentiginosa Maynard, *Strophia:* 1889, Contributions, **1**, p. 75, pl. 7, figs. 18-18a (Rum Key, interior on west side, Bahamas).

lepidum Clench and Aguayo, *Cerion vulneratum:* 1951, Revista, **8**, p. 76, pl. 11, figs. 10-11 (Laguna, Punta de Mulas, Banes, Cuba).

lerneri Clench, *Cerion exemium:* 1956, American Museum Novitates no. 1794, p. 1, text figs. 1-2 (East Bimini, Bimini Islands, Bahamas).

leucophera Maynard and Clapp, *Strophiops:* 1925, Records, App., **10.** p. 181, pl. 52, figs. 1-2 (northern end of Great Guana Key [Exuma Group] Bahamas).

leva Maynard and Clapp, *Strophiops:* 1921, Records, App., **10.** p. 142, pl. 48, figs. 1-2 (rocks above Queen's stair-case, Nassau, New Providence, Bahamas).

levigata Maynard, *Strophia:* 1889, Contributions, **1.** p. 12, pl. 2, figs. 2-2b (west end of Little Cayman [Cayman Islands]).

liliorum Clench, *Cerion:* 1938, Bull. Mus. Comp. Zool., **80.** p. 527, pl. 2, figs. 2-4 (Next Point (east coast) 1½ miles ENE of Governor's Harbour, Eleuthera Island, Bahama Islands).

lineota Maynard, *Strophia:* 1889, Contributions, **1.** p. 20, pl. 2, figs. 7-7b (south side of Little Cayman and south side of Cayman Brac [Cayman Islands]). Is *C. pannosum* Mayn., Pilsbry 1901.

litorea Maynard and Clapp, *Strophiops:* 1921, Records, App., **10.** p. 133, pl. 30, figs. 7-8 (south border of Guana Key, Berry Islands, Bahamas).

livida Maynard, *Strophiops:* 1924, Suppl. Sale Catalogue, p. 4 (West Bay St., oppo. North Silver Key, Nassau, New Providence, Bahamas).

lobata Maynard and Clapp, *Strophiops:* 1921, Records, App., **10.** p. 134, pl. 30, figs. 7-8 (Eastern Soldier Key [Berry Islands] Bahamas).

Longidens Maynard: 1896, Contributions, **3.** p. 39 (type species, *Strophia pannosa* Maynard, original designation).

longidens Pilsbry, *Cerion:* 1902, M. of C., (2) **14.** p. 212, pl. 32, figs. 23-24 (Cabo Cruz, Cuba).

lucayanorum Clench, *Cerion* (*Strophiops*): 1938, Memorias, **12.** p. 326, pl. 25, fig. 2 (NW portion of Mores Island, 32 miles NW of Southwest Point, Great Abaco Island, Bahama Islands).

ludovici de la Torre, *Cerion ceiba:* 1954, Revista, **9.** p. 41, pl. 5, fig. 4 (coast between Canasí and Playa de Palmarego, Matanzas Province, Cuba).

macrodon Aguayo and Jaume, *Cerion:* 1951, Revista, **8.** p. 12, pl. 1, fig. 9 (Cayo Borracho, east of Cayo Francés, Caibarién, Las Villas, Cuba).

macularia Maynard, *Strophiops:* 1913, Records, App., **5.** p. 189 (south shore of New Providence, west side of first sound to 2 miles west to a salina).

madama Sánchez Roig, *Cerion:* 1951, Revista, **7.** p. 112, pl. 18, fig. 9 (Cayo Madama, Bahía Arroyo Blanco, Mayarí, Oriente, Cuba). Is *C. alleni* Torre. See notes, this report.

magister Pilsbry and Vanatta, *Cerion mumia:* 1896, Proc. ANSP, p. 322, pl. 11, fig. 4 (Matanzas, Cuba).

maisianum Pilsbry, *Cerion politum:* 1902, M. of C., (2) **14.** p. 218, pl. 30, figs. 89-91 (Punta Maisi, Cuba). Is *C. politum* Maynard. See notes, this report.

major Beck, *Pupa ura:* 1837, Index Molluscorum, p. 82 [see note under *bidens* Beck].

major Küster, *Pupa multicosta:* 1845, Conchylien-Cabinet, (2) **1**, pt. 5, p. 77, pl. 10, figs. 1-2 (West Indies).

major Pfeiffer, *Pupa mumiola:* 1854, Malakozoologische Blätter, **1**, pl. 3, fig. 6 (Playa de Indios, Matanzas, Cuba). Not a subspecies but the name was used to indicate a large form.

maloneí Clench, *Cerion* (*Strophiops*): 1937, Nautilus, **51**, p. 20, pl. 3, fig. 6 (3½ miles SE of Simms, Long Island, Bahamas).

manatiense Aguayo and Jaume, *Cerion:* 1951, Revista, **8**, p. 9, pl. 1, fig. 4 (Loma Tabaco, SW of Bahía de Manatí, Oriente, Cuba).

manica Lamarck, *Pupa:* 1830, Encyclopédie Méthodique, **2**, pt. 2, p. 401 [error for *mumia* Brug.].

mariae Maynard and Clapp, *Strophiops:* 1921, Records, App., **10**, p. 128, pl. 24, fig. 10; pl. 25, fig. 5 (Maria Key, Little Exuma, Bahamas).

mariclinum Hand, *Cerion johnsoni:* 1926, Nautilus, **40**, p. 38 [*nomen nudum*].

mariclinum "Torre" Pilsbry, *Cerion johnsoni:* 1927, Nautilus, **40**, p. 74, pl. 1, fig. 10 (Mariel, Pinar del Río, Cuba).

mariguanense Clench, *Cerion* (*Strophiops*): 1933, Proc. New England Zool. Club, **13**, p. 94, pl. 1, fig. 3 (south coast of Mariguana Island, Bahamas).

maritima Pfeiffer, *Pupa:* 1839, Archiv für Naturgesch. Wiegmann, **5**, pt. 1, p. 353, (Punta de Maya, Matanzas, Cuba).

marmorata Pfeiffer, *Pupa:* 1847, Zeitschrift für Malakozoologie, **4**, p. 83 (no locality [Fortune Island, Crooked Island Group, Bahamas]).

marmorosa Maynard and Clapp, *Strophiops:* 1920, Records, App., **10**, p. 125, pl. 24, figs. 6-7 (Well Key a little north of Leward Stocking Key [Exuma Group] Bahamas).

martensi Weinland, *Pupa:* 1862, Malakozoologische Blätter, **9**, p. 194 (Crooked Island, Bahamas).

martiniana Küster, *Pupa:* 1844, Conchylien-Cabinet, (2) **1**, pt. 15, p. 75, pl. 11, figs. 3-4 (West Indies [Grand Cayman, Cayman Islands]).

maynardi Pilsbry and Vanatta, *Cerion* (*Maynardia*): 1895, Proc. ANSP, p. 210 (Abaco Island [Bahamas]).

Maynardia Dall: 1894, Bull. Mus. Comp. Zool., **25**, p. 122 (type species *Strophia neglecta* Maynard).

mayoi Maynard and Clapp, *Strophiops:* 1921, Records, App., **10**, p. 148, pl. 43, figs. 9-10 (field east of Mackey St., Nassau, New Providence, Bahamas).

mclcani Clench, *Cerion* (*Strophiops*): 1937, Nautilus, **51**, p. 22, pl. 3, fig. 7 (1 mile east of O'Neills, Long Island, Bahamas).

media Maynard *Strophia:* 1896, Contributions, **3**, p. 18, pl. 4, figs. 3-4 (Cuba). Is *C. mumia* Brug., Pilsbry 1902.

melanostomum Clench, *Cerion:* 1934, Proc. Boston Soc. Nat. Hist., **40**, p.

212, pl. 2, figs. a and c (Mortimers, south end of Long Island, Bahama Islands).

microdon Pilsbry and Vanatta, *Cerion incrassatum:* 1896, Proc. ANSP, p. 328, pl. 11, fig. 5 ([Gibara, Oriente] Cuba).

microstomum Pfeiffer, *Pupa:* 1854, Malakozoologische Blätter, **1**, p. 207, (Punta de Jicaco [Peninsula de Hicacos, Matanzas Prov.] Cuba).

migratoria Maynard and Clapp, *Strophiops:* 1921, Records, App., **10**, p. 147, pl. 43, figs. 3-4 (Methodist Sunday School grounds, Sherley St., Nassau, New Providence, Bahamas).

miguelete Sánchez Roig, *Cerion:* 1951, Revista, **7**, p. 113, pl. 19, fig. 5 (Cayo Miguel, Boca de Yaguaneque, Cananova, Sagua de Tánamo, Cuba). Is *C. alleni* Torre. See notes, this report.

milleri Pfeiffer, *Pupa:* 1867, Malakozoologische Blätter, **14**, p. 129 (Duck Cay, Exuma Group, Bahama Islands).

minima Maynard, *Strophiops:* 1924, Catalogue, p. 4 (St. James corner, East Nassau, New Providence, Bahamas).

minor Küster, *Pupa striatella:* 1847, Conchylien-Cabinet, (2) **1**, pt. 15, p. 92, pl. 11, figs. 13-15 (Haiti).

minusculum Aguayo and A. de la Torre, *Cerion ceiba:* 1952, Revista, **9**, p. 35, text fig. 1 (east of Boca del Río Canasí, Matanzas, Cuba).

minuta Maynard and Clapp, *Strophiops palmata:* 1920, Records, App., **10**, p. 120, pl. 21, fig. 5 (Wax Key [Exuma Group] Bahamas).

miramarae Sánchez Roig, *Cerion:* 1951, Revista, **7**, p. 116, pl. 18, fig. 1 (Miramar, Punta Domingo, Nuevitas, Camagüey, Cuba).

mitra Maynard and Clapp, *Strophiops:* 1920, Records, App., **10**, p. 118, pl. 2, figs. 4-5 (south end of Great Guana Key [Exuma Group] Bahamas).

mixta Maynard and Clapp, *Strophiops:* 1921, Records, App., **10**, p. 130, pl. 27, figs. 5-6 (Bonds Key, Berry Islands, Bahamas).

mobile Maynard and Clapp, *Strophiops:* 1921, Records, App., **10**, p. 146, pl. 41, figs. 9-10 (west end of Rose Island, New Providence, Bahamas).

monaense Clench, *Cerion:* 1951, Journal de Conchyliologie, **90**, p. 274, figs. 7-11 (Mona Island, Puerto Rico).

montana Maynard, *Strophiops:* 1924, Catalogue, Suppl., p. 3 (Sunnyside estate, East Bay St., Nassau, New Providence Bahamas).

moralesi Clench and Aguayo, *Cerion torrei:* 1951, Revista, **8**, p. 77, pl. 11, figs. 13-14 (Playa de Morales, 11 kilometers SE of Banes, Oriente, Cuba).

moreleti Clench and Aguayo, *Cerion iostomum:* 1951, Revista, **8**, p. 73, pl. 11, fig. 6 (Punta del Este, Isle of Pines, Cuba).

mortuorium de la Torre, *Cerion:* 1953, [MS name in the synonymy of *Cerion vulneratum feriai* Clench and Aguayo].

morula Maynard and Clapp, *Strophiops:* 1915, Records, App., **6**, p. 179 (Spruce Key, [4 miles east of Nassau] New Providence, Bahamas).

mossi Clench, *Cerion:* 1952, Revista, **8**, p. 108 [new name for *Cerion paucicostatum* Clench 1934 *non* Torre 1929].

multa Maynard, *Strophiops:* 1913, Records, App., **5,** p. 197 (northern portion of Fleming Key [about 20 miles NE of New Providence] Bahamas). Is *C. exiguum* Mayn., Clench 1952.

Multicostata Maynard: 1920, Records, App., **10,** p. 69; 126 (type species, *M. eximea* Maynard). [Is a synonym of *Multistrophia* Maynard.]

multicostata "Küster" Sowerby, *Pupa:* 1875, Conchologia Iconica, **20,** pl. 2, fig. 13 (Cuba) [error for *Pupa multicostum* Küster].

multicostum Küster, *Pupa:* 1845, Conchylien-Cabinet, (2) **1,** pt. 15, p. 77, pl. 10, figs. 3-4; pl. 11, figs. 6-7 (West Indies).

multistriatum Pilsbry and Vanatta, *Cerion:* 1896, Proc. ANSP, p. 335, pl. 11, fig. 8 (Crooked Island, Bahamas).

Multostrophia Maynard: 1894, Contributions, **2,** p. 177 (type species *Strophia eximea* Maynard, original designation).

mumia Bruguière, *Bulimus:* 1792, Encyclopédie Méthodique, **1,** p. 384 (Ocean American [Matanzas, Cuba, *fide* Pilsbry 1902, p. 225]).

mumia Sowerby, *Pupa:* 1834, The Genera of Recent and Fossil Shells, pt. 41, fig. 2 (no locality given). [Is *Cerion regium* Benson, *non mumia* Bruguière.]

mumiola Pfeiffer, *Pupa:* 1839, Archiv für Naturgesch. Weigmann, **5,** pt. 1, p. 353 (Playa de Indios, Matanzas, Cuba).

muralia Maynard and Clapp, *Strophiops:* 1921, Records, App., **10,** p. 151, pl. 47, figs. 5-6 (in walls at East Nassau, New Providence, Bahamas).

muta "Maynard" Batchelder, *Strophia:* 1951, Jour. Soc. Bibliography Natural History, **2,** pt. 7, p. 238 [error for *mutata* Maynard].

mutata Maynard, *Strophia cinerea:* 1894, Contributions, **2,** p. 125, fig. 37a (NW part of Long Key [=Athol Id.] NE of Nassau, New Providence, Bahamas). Is *C. varium* Bonnet, Pilsbry 1902.

mutatoria Maynard and Clapp, *Strophiops:* 1920, Records, App., **10,** p. 116, pl. 1, figs. 3-4 (south end of Great Guana Key [Exuma Group] Bahamas).

nana Maynard, *Strophia:* 1889, Contributions, **1,** p. 27, pl. 2, figs. 11-11d (west end of Little Cayman [Cayman Islands]).

navalis Maynard and Clapp, *Strophiops:* 1920, Records, App., **10,** p. 124, pl. 20, figs. 8-10 (north end of Ship Channel Key [Exuma Group] Bahamas).

nebula Maynard and Clapp, *Strophiops:* 1920, Records, App., **10,** p. 122, pl. 24, fig. 1 (first Key north of Stocking Island, Great Exuma, Bahamas).

neglecta Maynard, *Strophia:* 1894, Contributions, **2,** p. 150, fig. 47, (one mile west of Fort Charlotte, Nassau, New Providence, Bahamas). Is *C. coryi* Maynard, Pilsbry 1902.

nitela Maynard, *Strophia:* 1889, Contributions, **1,** p. 73, pl. 17, figs. 16-16a (west end of Little Cayman [Cayman Islands]). Is *C. levigatum* Maynard, Pilsbry 1901.

niteloides Dall, *Cerion* (*Maynardia*): 1896, Bull. Lab. Nat. Hist. State Univ. Iowa, **4,** no. 1, p. 15, pl. 1, fig. 2 (Water Cay, Salt Cay Bank, Bahamas).

nivea Maynard, *Strophia curtissii:* 1894, Contributions, **2,** p. 102, (cemetery between Waterloo and Nassau, New Providence, Bahamas).

nivia Maynard, *Strophiops:* 1894, Records, App., **5,** p. 186 [error for *nivea* Maynard 1894].

noriae Aguayo and Sánchez Roig, *Cerion mumia:* 1853, Memorias, **21,** p. 285, pl. 32, fig. 8 (La Noria, Cojimar, Cuba).

normale Pilsbry and Black, *Cerion sladeni:* 1930, Proc. ANSP, **82,** p. 292, pl. 21, fig. 2 (Purser Point, Andros, Bahamas).

normalis Beck, *Pupa chrysalis:* 1837, Index Molluscorum, p. 82 [see note under *bidens* Beck].

normalis Beck, *Pupa uva:* 1837, Index Molluscorum, p. 82 [see note under *bidens* Beck].

normanii Maynard and Clapp, *Strophiops:* 1920, Records, App., **10,** p. 123, pl. 20, fig. 5 (West Hill, Little Norman Key [Exuma Group] Bahamas).

northropi Dall, *Cerion* (*Strophiops*): 1905, Smithsonian Misc. Collect., **47,** p. 442, pl. 58, fig. 11 (one of the westernmost islets near Gun Cay, Bahamas). Is *C. pillsburyi* P. and V., Clench 1942.

novita Maynard and Clapp, *Strophiops:* 1921, Records, App., **10,** p. 148, pl. 45, figs. 1-2 (Park west of Fort Montague, East Nassau, New Providence, Bahamas).

nuda Maynard, *Strophia:* 1889, Contributions, **1,** p. 29, pl. 2, figs. 12a-b (near Clarence Harbor, Long Island, Bahamas).

oberholseri Maynard, *Strophiops:* 1913, Records, App., **5,** p. 193 (Southwest Bay, New Providence, Bahamas).

obesum Dall, *Cerion glans:* 1905, Smithsonian Misc. Collect., **47,** p. 437, pl. 58, fig. 15 (Long Cay, North Bight of Andros and Mangrove Cay, South Bight of Andros, Bahamas).

obesum "Torre" Clench and Aguayo, *Cerion:* 1951, Revista, **8,** p. 80 [a *nomen nudum* appearing as a synonym under *C. paucicostatum* Torre].

obliterata Maynard, *Strophia scripta:* 1896, Contributions, **3,** p. 5, pl. 1, figs. 5-6 (Matanzas, Cuba). Is *C. chrysalis* Fér., Pilsbry 1902.

obliterata Maynard, *Strophiops:* 1913, Records, App., **5,** p. 197 (East Booby Rock [16 miles NE of] New Providence, Bahamas). [Is *S. sula* Maynard and Clapp, new name for *obliterata* Maynard 1913, *non* 1896].

obscura Maynard, *Strophia:* 1896, Contributions, **3,** p. 21, pl. 3, figs. 5-6 (Cayo Birde del Norte, Cuba). Is *C. sagraianum* Pfr., Pilsbry, 1902.

obtusa Maynard and Clapp, *Strophiops:* 1921, Records, App., **10,** p. 132, pl. 29, figs. 9-10 (Cat Key, Berry Islands, Bahamas).

orbicularia Maynard, *Strophia:* 1890, Contributions, **1,** pl. 16, fig. 6a-b [not described; Inagua, Bahamas, label on type specimens].

orbicularis "Maynard" Pilsbry, *Strophia:* 1902, M. of C., (2) **14,** p. 281 [error for *orbicularia* Maynard].

orientale Clench and Aguayo, *Cerion:* 1951, Revista, **8,** p. 79, pl. 11, fig. 16 (Punta Nigra, 18 kilometers SW of Punta Maisi, Oriente, Cuba).

ornatula Maynard, *Strophiops:* 1913, Records, App., **5,** p. 197 (Current Settlement, Eleuthera, Bahamas). Is *C. laeve* Plate, Clench 1952.

ornatula-clappi Maynard, *Strophiops:* 1913, Records, App., **5,** p. 198 (north of Current Settlement, Eleuthera, Bahamas). Is *C. laeve* Plate, Clench 1952.

ornatula-rufina Maynard, *Strophiops:* 1913, Records, App., **5,** p. 198 (south of Current Settlement, Eleuthera, Bahamas).

ornatum Pilsbry and Vanatta, *Cerion torrei:* 1898 [1899] Proc. ANSP, p. 476, text figs. 3-4 (Vita, Cuba).

oscula Maynard and Clapp, *Strophiops:* 1921, Records, App., **10,** p. 146, pl. 42, figs. 5-6 (Old Thompson Place, Bay St., Nassau, New Providence, Bahamas).

oweni Dall, *Cerion:* 1905, Smithsonian Misc. Collect., **47,** p. 443, pl. 58, fig. 12 (south side of Little Abaco, opposite Marsh Harbor and [at] Riding Point, Grand Bahama, Bahamas).

palidula Maynard and Clapp, *Strophiops:* 1921, Records, App., **10,** p. 145, pl. 40, figs. 9-10 (east end of Hog Island, Nassau, New Providence, Bahamas).

pallida Maynard, *Strophia:* 1889, Contributions, **1,** p. 70, pl. 2, figs. 14-14a (south shore of Inagua, 15-20 miles from Matthewstown, Bahamas). Is *C. rubicundum* Menke, Pilsbry 1902.

palmata Maynard and Clapp, *Strophiops:* 1920, Records, App., **10,** p. 120, pl. 21, figs. 1-2 (Wax Key [Exuma Group] Bahamas).

palmeri Sánchez Roig, *Cerion:* 1948, Revista, **6,** p. 69, pl. 1, fig. 6 (Cayo Romano (22° 24′ N; 76° 6′ W) Cuba).

panda Maynard and Clapp, *Strophiops:* 1921, Records, App., **10,** p. 136, pl. 33, figs. 7-8 (Saddleback Key, north Andros, Bahamas).

pandionis Aguayo and Jaume, *Cerion vulneratum:* 1951, Revista, **8,** p. 1, pl. 2, figs. 1-3 (Cayo Guincho, NE of the bay of Puerto Padre, Oriente, Cuba).

pannosa Maynard, *Strophia:* 1889, Contributions, **1,** p. 10, pl. 1, figs. 2, 13 (west end of Little Cayman [Cayman Islands]).

Paracerion Pilsbry and Vanatta: 1895, Proc. ANSP, **47,** p. 206. [Two species are given, *tridentatum* P. and V. and *basistriatum* P. and V., type species, here selected is *Cerion tridentatum* P. and V.]

paredonis Pilsbry, *Cerion cumingianum:* 1902, M. of C., (2) **14,** p. 199, pl. 32, figs. 21-22 (Cayo Paredon Grande, north shore of Puerto Principe [Camagüey] Cuba).

parva Maynard, *Strophia:* 1889, Contributions, **1,** p. 24, pl. 2, figs. 9-9b (west end of Cayman Brac [Cayman Islands]). Is *C. pannosum* Mayn., Pilsbry 1901.

parvulum Aguayo and Jaume, *Cerion gundlachi:* 1951, Revista, **8,** p. 5, pl. 2, fig. 12 (Mono Ciego, east of Boca de la Bahía Manatí, Oriente, Cuba).

pastelilloensis Sánchez Roig, *Cerion:* 1951, Revista, **7.** p. 114, pl. 18, fig. 4 (Pastelillo, Camagüey, Cuba).

paucicostatum Clench, *Cerion:* 1934, Proc. Boston Soc. Nat. Hist., **40.** p. 209, pl. 2, fig. E (Miller Hill, southern Eleuthera, Bahama Islands). Is *C. mossi* Clench, Clench 1952.

paucicostatum de la Torre, *Cerion:* 1929, Nautilus, **42.** no. 3, pl. 4, figs. 8-9 [no description] (Cabo Maisi, Oriente, Cuba).

pauciculptum Clench and Aguayo, *Cerion* (*Umbonis*): 1952, Occasional Papers on Mollusks, **1.** no. 17, p. 425, pl. 54, figs. 1-2 (Punta de Musica, Bahía de Samá, Banes, Cuba).

pauli M. Smith, *Cerion:* 1943, Nautilus, **57.** p. 60, pl. 7, fig. 8 (Stewart Manor Hill, Exuma, Bahamas).

pentodon Menke, *Helix:* 1846, Zeitschrift für Malakozoologie, **3.** p. 128, (locality unknown); Pfeiffer 1859, Mono. Heliceorum Viventium, **4.** p. 154 (Curaçao). [Is *Cerion uva* Linné—only a young shell (Smith 1898)].

pepperi Bartsch, *Cerion* (*Strophiops*): 1913, Proc. U. S. Nat. Mus., **46.** p. 108, pl. 3, figs. 1, 3, 7-12 (2 miles south of Mastic Point, Andros, Bahamas).

peracuta Bartsch, *Cerion:* 1931, Science (n.s.), **73.** p. 419, [*nomen nudum*].

peracutum Clench and Aguayo, *Cerion sagraianum:* 1951, Revista, **8.** p. 75, pl. 11, fig. 9 (Boca de Jaruco, Habana Province, Cuba).

perantiqua Maynard and Clapp, *Strophiops:* 1920, Records, App., **10.** p. 115, pl. 1, figs. 1-2 (south end of Great Guana Key [Exuma Group] Bahamas).

percostatum Pilsbry and Vanatta, *Cerion regina:* 1895, Proc. ANSP, p. 208 (Turks Island [Bahamas]).

periculosum Clench, *Cerion* (*Strophiops*): 1934, Proc. Boston Soc. Nat. Hist., **40.** p. 215, pl. 2, fig. B (South Cay, Mira Por Vos Group, Bahamas).

perplexa Maynard, *Strophia:* 1889, Contributions, **1.** p. 71, pl. 7, figs. 15-15a (Cayman Brac, 2 miles from west end [Cayman Islands]). Is *C. pannosum* Mayn., Pilsbry 1901.

persuasa Maynard and Clapp, *Strophiops:* 1921, Records, App., **10.** p. 131, pl. 28, figs. 9-10 (along shore north of Fresh Creek, Andros, Bahamas).

phoenecia Maynard and Clapp, *Strophiops:* 1921, Records, App., **10.** p. 149, pl. 45, figs. 3-4 (Waterloo, East Nassau, New Providence, Bahamas).

picta Maynard, *Strophia:* 1889, Contributions, **1.** p. 18, pl. 2, figs. 6-6b (west end of Little Cayman [Cayman Islands]). Is *C. levigatum* Mayn., Pilsbry 1901.

picturata Maynard and Clapp, *Strophiops:* 1921, Records, App., **10.** p. 135, pl. 32, figs. 7-8 (fossil, Cabbage Key, Berry Islands, Bahamas).

pillsburyi Pilsbry and Vanatta, *Cerion:* 1897, Proc. ANSP, **49.** p. 366, text fig. 5, (Gun Cay [Bimini] Bahamas).

pilsbryi Maynard, *Strophia:* 1894, Contributions, **2.** p. 170, fig. 55 (Goat

Key, Middle Bight, Andros, Bahamas). Is *C. griseum* Mayn., Pilsbry, 1902.

pineria Dall, *Cerion* (*Maynardia*): 1895, Proc. U. S. Nat. Mus., **18,** p. 6, (Isle of Pines [Cuba]).

pinguis Humphrey, *Pupa:* 1797, Museum Calonnianum, p. 64 [see note under *clathrata* Humphrey].

Pinguita Maynard: 1896, Contributions, **3,** p. 30 [type species, *Strophia dimidiatia* [*sic*] Pfeiffer, monotypic].

piraticus Clench, *Cerion:* 1937, Proc. New England Zool. Club, **16,** p. 64, pl. 3, fig. 1 (Southeast Point, 12 miles SE of Abrahams Bay, Mariguana Island, Bahamas).

platei Clench, *Cerion* (*Strophiops*): 1933, Proc. New England Zool. Club, **13,** p. 90, pl. 1, figs. 7-8 (Bight road, Cat Island, Bahamas).

plebia Maynard and Clapp, *Strophiops:* 1921, Records, App., **10,** p. 130, pl. 28, figs. 3-4 (Lignum Vitae Key, Berry Islands, Bahamas).

plegmatum Dall, *Cerion* (*Strophiops*): 1905, Smithsonian Misc. Collect., **47,** p. 441, pl. 58, fig. 5 (Exuma Island, Bahamas).

poeyi Aguayo and Sánchez Roig, *Cerion sanctaecruzense:* 1953, Memorias, **21,** p. 293, pl. 32, fig. 11 (Trinidad, Cuba).

polita Maynard, *Strophia marmorata:* 1896, Contributions, **3,** p. 14, pl. 3, figs. 3-4 (Cabo Cruz [is Cabo Maisi] Cuba).

porcina Maynard and Clapp, *Strophiops:* 1921, Records, App., **10,** p. 132, pl. 29, figs. 7 8 (Frazar's Hog Key, Berry Islands, Bahamas).

portillonis Welch, *Cerion ramsdeni:* 1934, Nautilus, **47,** p. 105, pl. 11, fig. 2 (near Portillo, 10 kilometers east of Ensenada de Mora, Oriente, Cuba).

portuspatris Aguayo and Sánchez Roig, *Cerion josephi:* 1953, Memorias, **21,** p. 291, pl. 32, fig. 10 (Cayo Juan Claro, Bahía de Puerto Padre, Oriente, Cuba).

praedicta Maynard and Clapp, *Strophiops:* 1915, Records, App., **6,** p. 181, (fossil, Great Pimlico [30 miles NE of New Providence] Bahamas). Is *C. uniforme* Mayn., Clench 1952.

praedivina Maynard, *Strophiops:* 1913, Records, App., **5,** p. 196 (fossil, Upper Fleming Key [20 miles NE of New Providence] Bahamas). Is *C. exiguum* Mayn., Clench 1952.

praedivina-universa Maynard, *Strophiops:* 1913, Records, App., **5,** p. 196 (fossil, upper Fleming Key [20 miles NE of New Providence] Bahamas). Is *C. exiguum* Mayn., Clench 1952.

prestoni Sánchez Roig, *Cerion:* 1951, Revista, **7,** p. 118, pl. 19, fig. 4 (Preston, Nipe, Cuba).

pretiosus Sánchez Roig, *Cerion:* 1951, Revista, **7,** p. 115 pl. 18, figs. 2 2a (Playa Bonita, frente al Faro de Maternillos, Camagüey, Cuba).

primigenia Maynard, *Strophiops:* 1913, Records, App., **5,** p. 184 (fossil beneath a sand cliff, east end of Salt Key, New Providence, Bahamas).

primordia Maynard and Clapp, *Strophiops:* 1921, Records, App., **10,** p. 132, pl. 29, figs. 1 2 (Great Stirrup Key [Berry Islands] Bahamas).

prisca Maynard and Clapp, *Strophiops:* 1915, Records, App., **6.** p. 182 (fossil, east end of Salt Key, New Providence, Bahamas).

proavita Maynard and Clapp, *Strophiops:* 1921, Records, App., **10.** p. 129, pl. 26, figs. 9-10 (fossil, Goat Key, Great Harbor, Berry Islands, Bahamas).

processa Maynard and Clapp, *Strophiops:* 1920, Records, App., **10.** p. 116, pl. 1, figs. 7-8 (south end of Great Guana Key [Exuma Group] Bahamas).

procliva Maynard and Clapp, *Strophiops:* 1921, Records, App., **10.** p. 134, pl. 31, figs. 5-6 (Goat Key, Great Harbor [Berry Islands] Bahamas).

profunda Maynard and Clapp, *Strophiops:* 1921, Records, App., **10.** p. 129, pl. 27, figs. 1-2 (fossil, Goat Key, Great Harbor, Berry Islands, Bahamas).

prognata Maynard and Clapp, *Strophiops:* 1920, Records, App., **10.** p. 118, pl. 2, figs. 8-9 (south end of Great Guana Key [Exuma Group] Bahamas).

progressa Maynard and Clapp, *Strophiops:* 1920, Records, App., **10.** p. 119, pl. 2, figs. 1-2 (north end of Great Guana Key [Exuma Group] Bahamas).

proteus Pfeiffer and Gundlach, *Pupa:* 1861, Malakozoologische Blätter, **7.** p. 19, (Gibara, Cuba). Is *C. dimidiatum* Pfr., Pilsbry 1902.

pseudocyclostomum Aguayo and Sánchez Roig, *Cerion:* 1953, Memorias, **21.** p. 289, pl. 32, fig. 13 (Cayo Francés, Caibarién, Cuba).

pudicum Pilsbry, *Cerion bryanti:* 1902, M. of C., (2) **14.** p. 273, pl. 46, figs. 17-18 (no locality given [Great Inagua]).

pulla Maynard and Clapp, *Strophiops:* 1920, Records, App., **10.** p. 122, pl. 23, figs. 3-4 (small key opposite Roseville, Great Exuma, Bahamas).

Pulpa Poey: 1858, Memorias sobre la Historia Natural de la Isla de Cuba, **2.** p. 30 [error for *Pupa;* type species, *Pulpa sculpta* Poey = *Cerion sculptum* Poey].

pumilia Maynard, *Strophia grayi:* 1894, Contributions, **2.** p. 143, fig. 44B (NE end of Highburn Key [Exuma Group] Bahamas).

pupa Röding, *Cerion:* 1798, Museum Boltenianum, p. 90 [based upon *Helix pupa* Gmel., a species in the genus *Mastus*].

pupilla Dall, *Cerion* (*Strophiops*) *variabile:* 1905, Smithsonian Misc. Collect., **47.** p. 440, pl. 58, fig. 1 (Red Bay, northwest end of Andros, Bahamas).

purpurea Maynard, *Strophiops:* 1913, Records, App., **5.** p. 188 (Creek Settlement and one mile east [East Point Light] New Providence, Bahamas).

pusilia "Maynard" Batchelder, *Strophiops:* 1951, Jour. Soc. Bibliography Nat. Hist., **2.** p. 255 [error for *pusilla* Maynard and Clapp].

pusilla Maynard and Clapp, *Strophiops:* 1921, Records, App., **10.** p. 127, pl. 22, fig. 5 (key near Long Rock, Great Exuma, Bahamas).

pygmaeum Pilsbry and Vanatta, *Cerion:* 1896, Proc. ANSP, p. 334, pl. 11, fig. 9 (Gibara, Cuba). Is *C. microdon* P. and V. See Notes, this report.

pygmea Maynard, *Strophiops:* 1924, Catalogue, Suppl., p. 4 (fossil, crab holes, St. James Corner, Nassau, New Providence, Bahamas).

ralla Maynard and Clapp, *Strophiops:* 1921, Records, App., **10.** p. 137,

pl. 34, figs. 8-9 (Joulter Keys, north of Andros, Bahamas).

ramsdeni "Torre" Welch, *Cerion:* 1934, Nautilus, **47.** p. 105, pl. 11, fig. 1a-e (Playa Rincon, Ensenada de Mora, Oriente, Cuba).

rara Maynard and Clapp, *Strophiops:* 1921, Records, App., **10.** p. 133, pl. 31, figs. 1-2 (fossil, west side, Cabbage Key, Berry Islands, Bahamas).

recessa Maynard and Clapp, *Strophiops:* 1920, Records, App., **10.** p. 122, pl. 24, figs. 2-3 (southern portion of Stocking Island, Great Exuma, Bahamas).

rediviva Maynard, *Strophiops:* 1913, Records, App., **5.** p. 187 (west of St. Paul quarry, East Nassau, New Providence, Bahamas).

regia Benson, *Pupa:* 1849, Ann. Mag. Nat. Hist., (2) **4.** p. 125 (Nanking, China [Castle Island, Bahamas]).

regina Pilsbry and Vanatta, *Cerion* (*Maynardia*): 1895, Proc. ANSP, p. 208; *ibid.*, 1896, p. 330, pl. 11, figs. 23-24 (Turks Island [Bahamas]).

regula Maynard, *Strophia:* 1894, Contributions, **2.** p. 161, fig. 52 (Fresh Creek, near settlement, Andros, Bahamas). Is *C. griseum* Mayn., Pilsbry 1902.

rehderi Clench and Aguayo, *Cerion* (*Umbonis*): 1952, Occ. Papers on Mollusks, **1.** no. 17, p. 422, pl. 57, fig. 2 (Jackline, one mile west of Conch Shell Point, Great Inagua, Bahama Islands).

reincarnata Maynard and Clapp, *Strophiops:* 1921, Records, App., **10.** p. 148, pl. 44, figs. 1-2 (Ocean Hole, east of Mackey St., Nassau, New Providence, Bahamas).

relequa Maynard and Clapp, *Strophiops:* 1921, Records, App., **10.** p. 130, pl. 27, figs. 7-8 (Holms Key, Berry Islands, Bahamas).

repetita Maynard and Clapp, *Strophiops:* 1921, Records, App., **10.** p. 149, pl. 45, figs. 5-6 (fields off Kemp's road, East Nassau, New Providence, Bahamas).

restricta Maynard, *Strophia:* 1894, Contributions, **2.** p. 175, fig. 58 (middle of Goat Key, Middle Bight, Andros, Bahamas). Is *C. griseum* Mayn., Pilsbry 1902.

reticulatum Dall, *Cerion owani:* 1905, Smithsonian Misc. Collect., **47.** p. 443, pl. 58, fig. 8 (Sugar Loaves Rocks, NW of Elbow Cay, Great Abaco, Bahamas). Is *C. bendalli* P. and V., Clench 1938a.

rhyssum Dall, *Cerion* (*Strophiops*): 1905, [in] The Bahama Islands, The Geographic Society of Baltimore, Maryland, ed. by G. B. Shattuck, p. 34, pl. 12, fig. 46 (fossil in aeolian rock, Station 14, small unnamed key south of Reids Cay, Middle Bight, Andros, Bahamas).

ricardi Clench and Aguayo, *Cerion:* 1951, Revista, **8.** p. 71, pl. 11, fig. 2 (Punta de Tarará, Habana Province, Cuba).

ritchiei Maynard, *Strophia:* 1894, Contributions, **2.** p. 135, fig. 41 (Highburu Key [Exuma Group] Bahamas).

robusta Maynard, *Strophia cinerea:* 1894, Contributions, **2.** p. 121, fig.

36a-b (north side of Hog Island, New Providence, Bahamas). Is *C. varium* Bonnet, Pilsbry 1902.

rocai Clench and Aguayo, *Cerion tridentatum:* 1953, Torreia, no. 18, p. 2, text fig. 2 (Lagunas Salobres de Boca de Guanabo, Habana, Cuba).

romanocnsis Aguayo and Sánchez Roig, *Cerion circumscriptum:* 1953, Memorias, **21,** p. 289, pl. 32, figs. 12-13 (Cayo Romano, Camagüey, Cuba). Is *C. sanzi* P. and V. See notes, this report.

rosacea Maynard and Clapp, *Strophiops:* 1921, Records, App., **10,** p. 139, pl. 35, figs. 7-8 (West [North?] Silver Key, Nassau, New Providence, Bahamas).

rosea Maynard and Clapp, *Strophiops:* 1921, Records, App., **10,** p. 151, pl. 48, figs. 9-10 (fossil, north east end of Rose Island, New Providence, Bahamas).

royi Aguayo and Jaume, *Cerion:* 1951, Revista, **8,** p. 7, pl. 1, fig. 1 (Cayo Cruz, northern Camagüey, Cuba). Is *C. sanzi* Pils. and Van. See notes, this report.

rubicunda Menke, *Pupa:* 1829, Verzeichnis Conchy.-Samml. Malsburg. Pyrmont, p. 8 (no locality given [Great Inagua]).

rubiginosa Maynard and Clapp, *Strophiops:* 1921, Records, App., **10,** p. 147, pl. 43, figs. 1-2 (field east of Methodist church, Sherley St., Nassau, New Providence, Bahamas).

rubra Humphrey, *Pupa:* 1787, Museum Calonnianum, p. 64 [see note under *clathrata* Humphrey].

rudis Pfeiffer, *Pupa:* 1855, Malakozoologische Blätter, **2,** p. 102, pl. 5, figs. 1-2 (subfossil, Diamond, Blessing and Paradise Plantations, St. Croix, [Virgin Islands]).

rufimaculata Maynard, *Strophiops:* 1913, Records, App., **5,** p. 189 (south shore of New Providence, west side of salina to Sound Point, Bahamas).

rufina Maynard, *Strophiops:* 1913, Records, App., **5,** p. 198 (south of Current Settlement, Eleuthera, Bahamas). Is *C. hyattii* Mayn., Clench 1952.

rufolabris Beck, *Pupa uva:* 1837, Index Molluscorum, p. 82, [see note under *bidens* Beck].

rufula Maynard, *Strophiops:* 1924, Catalogue, Suppl., p. 3 (west side of Kemp's Road, St. James Corner, Nassau, New Providence, Bahamas).

russelli Clench, *Cerion:* 1938, Bull. Mus. Comp. Zool., **80,** p. 528, pl. 1, figs. 5-8 (near Turtle Cove, 4 miles NNE of The Bight, central Cat Island, Bahama Islands).

saccharimeta "Blanes" Pilsbry and Vanatta, *Cerion incanum:* 1898 [1899] Proc. ANSP, p. 447, text fig. 5 (Sugar Loaf Key, Florida).

saetiae Sánchez Roig, *Cerion:* 1948, Revista, **6,** p. 67, pl. 1, fig. 7 (Playa del Cristo-Saetia, Bahía de Nipe, Cuba).

sagraiana Pfeiffer, *Pupa:* 1847, Zeitschrift für Malakozoologie, **4,** p. 15, (Cayo Galindo [Matanzas] Cuba).

saguacnse Aguayo and Sánchez Roig, *Cerion sagraianum:* 1953, Memorias, **21,** p. 286, pl. 32, fig. 9 (Cayo Roteño, Sagua la Grande [Las Villas] Cuba).

sainthilarius Sánchez Roig, *Cerion:* 1951, Revista, **7,** p. 115, pl. 18, fig. 3 (Fuerte San Hilario, Sabinal, Nuevitas, Camagüey, Cuba).

salinaria Maynard, *Strophiops:* 1913, Records, App., **5,** p. 184 (Salt Key, New Providence, Bahamas).

sallei Pilsbry and Vanatta, *Cerion crassilabre:* 1896, Proc. ANSP, p. 325 (San Domingo). Is *C. yumaense* P. and V., here considered a synonym.

salvatori "Torre" Pilsbry, *Cerion:* 1927, Nautilus, **40,** p. 74, pl. 1, fig. 11 (Jaimanitas [Habana] Cuba).

sampsoni Maynard and Clapp, *Strophiops:* 1920, Records, App., **10,** p. 121, pl. 4, figs. 1, 10 (Sampson's Key [Stanyard Cay on chart—3½ miles NW of Great Guana Cay, Exuma Group] Bahamas).

sanchezi Clench and Aguayo, *Cerion:* 1953, Torreia, no. 18, p. 3, text figs. 4-5 (Lengua de Pajáro, Bahía de Lebiza, Mayarí, Oriente, Cuba). Is *C. alleni* Torre. See notes, this report.

sanctacruzense Aguayo and Jaume, *Cerion:* 1951, Revista, **8,** p. 10, pl. 1, fig. 14 (Sabanalamar, Santa Cruz del Sur, Camagüey, Cuba).

sanctamariae Aguayo and Jaume, *Cerion:* 1951, Revista, **8,** p. 13, pl. 1, fig. 13 (Cayo Santa Maria, NE of Caibarién, Las Villas, Cuba).

santesoni Maynard and Clapp, *Strophiops:* 1921, Records, App., **10,** p. 139, pl. 36, figs. 3-4; pl. 15, fig. 5 (north shore of New Providence, west of Nassau, Bahamas).

sanzi "Blanes" Pilsbry and Vanatta, *Cerion:* 1898 [1899] p. 478, text fig. 9 (Confites Key, Nuevitas [Camagüey] Cuba).

saona Vanatta, *Cerion:* 1924, Proc. ANSP, **75,** p. 360, text fig. 3 (Saona Island, Santo Domingo). Is *C. yumaense* P. and V., here considered a synonym.

sarcostomum Pilsbry and Vanatta, *Cerion:* 1896, Proc. ANSP, p. 331, pl. 11, fig. 16, (Little Inagua, Bahamas).

saugeti Aguayo and Jaume, *Cerion manatiense:* 1951, Revista, **8,** p. 9, pl. 1, fig. 3 (SW of Bahía de Nuevas Grandes, about 3½ miles from its mouth, Camagüey, Cuba).

saurodon Dall, *Cerion* (*Strophiops*) *variabile:* 1905, Smithsonian Misc. Collect., **47,** p. 440, pl. 58, fig. 14 (Red Bay, NW end of Andros Island, Bahamas).

saxitina Maynard and Clapp, *Strophiops:* 1921, Records, App., **10,** p. 145, pl. 41, figs. 1-2 (Hog Island, east of Three Bays, New Providence, Bahamas).

scalariformis Maynard and Clapp, *Strophiops:* 1920, Records, App., **10,** p. 116, pl. 1, figs. 5-6 (south end of Great Guana Key [Exuma Group] Bahamas). Is *C. asperum* M. and C., Clench and Aguayo 1952.

scalarina "Gundlach" Sowerby, *Pupa:* 1875, Conchologia Iconica, **20,** pl. 17, fig. 153 [figure and description is for *Granopupa scalaris* Benoit from

Sicily; the reference is to *Cerion scalarinum* Pfeiffer and Gundlach from Cuba].

scalarina Pfeiffer and Gundlach, *Pupa:* 1860, Malakozoologische Blätter, **7,** p. 19 (Gibara [Oriente] Cuba).

scalarinoides Plate, *Cerion glans:* 1907, Archiv für Rassen- und Gesell. Biologie, **4,** p. 595, pl. 4, fig. f (Green Cay [east of Tongue of the Ocean and west of Exuma bank] Bahama Islands).

scopulorum Aguayo and Jaume, *Cerion:* 1951, Revista, **8,** p. 11, pl. 1, fig. 8, (Punta SE of Cayo Mégano Grande and NE of Cayo Cruz, northern Camagüey, Cuba).

scripta Maynard, *Strophia:* 1896, Contributions, **3,** p. 3, pl. 1, figs. 3-4 (Cardenas [Matanzas] Cuba). Is *C. chrysalis* Fér., Pilsbry 1902.

sculpta Poey, *Pulpa* [*sic*]*:* 1858, Memorias sobre la Historia Natural de la Isla de Cuba, **2,** p. 30, pl. 2, fig. 22 ([northern coast of Pinar del Río] Cuba).

scutata Maynard and Clapp, *Strophiops:* 1921, Records, App., **10,** p. 133, pl. 31, figs. 3-4 (Petit Key [Berry Islands] Bahamas).

sellare Aguayo and Sánchez Roig, *Cerion sanzi:* 1953, Memorias, **21,** p. 291, pl. 32, fig. 6 (Silla de Cayo Romano, Camagüey, Cuba).

semipolita Maynard and Clapp, *Strophiops:* 1920, Records, App., **10,** p. 123, pl. 23, figs. 6-7 (3rd Key south of Roseville, Great Exuma, Bahamas).

Senieulus Maynard: 1896, Contributions, **3,** p. 17 (type species, *Strophia mumia* Bruguière, original designation). [Is a synonym of *Strophia* Albers.]

shrevei Clench and Aguayo, *Cerion* (*Umbonis*): 1952, Occ. Papers on Mollusks, **1,** no. 17, p. 436, pl. 57, fig. 4 (near North West Point, Little Inagua, Bahamas).

similaria Maynard and Clapp, *Strophiops:* 1921, Records, App., **10,** p. 128, pl. 26, figs. 5-6 (westernmost Brigadier [Brigantine, Exuma Group] Bahamas).

similaris "Maynard" Batchelder, *Strophiops:* 1951, Jour. Soc. Bibliography Natural History, **2,** p. 255 [error for *similaria* Maynard].

sisal Clench and Aguayo, *Cerion* (*Umbonis*): 1952, Occ. Papers on Mollusks, **1,** no. 17, p. 427, pl. 57, fig. 3 (east side—Boca de Mosquito, Mariel, Pinar del Río, Cuba).

sladeni Pilsbry and Black, *Cerion:* 1930, Proc. ANSP, **82,** p. 290, pl. 21, fig. 1 a-l (Mastic Cay, in Middle Bight, Andros, Bahamas).

smithii "Blanes" Pilsbry, *Cerion crassiusculum:* 1902, M. of C., (2) **14,** p. 202, pl. 32, fig. 38 (Sagua de Tánamo [Oriente] Cuba).

sparsa Maynard, *Strophiops:* 1924, Catalogue, Suppl., p. 3 (St. James Corner, East Nassau, Bahamas).

stevensoni Dall, *Cerion:* 1900, Nautilus, **14,** p. 65 (Long or Berry Island [Long Island] Bahamas).

striata Schumacher, *Pupa:* 1817, Essai Nouveau Système Vers Téstaces Copenhagen, p. 230. Refers to Chemnitz 1780, Conchylien-Cabinet, (1) **4,**

pl. 153, fig. 1439a-b. Is *C. mumia* Bruguière, Pilsbry 1902.

striatella "Férussac" Guerin-Meneville, *Pupa:* 1829?, Iconographie du Regne Animal de G. Cuvier, Mollusques, p. 16, pl. 6, fig. 12 (The Antilles [Puerto Rico]).

striatissimum Aguayo and Jaume, *Cerion salvatori:* 1953, Memorias, **21**, p. 274, pl. 31, fig. 8 (Playa de Santa Fé, Habana, Cuba).

strigis Aguayo and Sánchez Roig, *Cerion herrerai:* 1953, Memorias, **21**, p. 287, pl. 32, figs. 2, 4 (Cayo Brujas, Caibarién [Las Villas] Cuba).

stritella Humphrey, *Pupa:* 1797, Museum Calonnianum, p. 64 [see note under *clathrata* Humphrey].

strobilus Beck, *Pupa:* 1837, Index Molluscorum, p. 82, [*nomen nudum*].

Strophia Albers: 1850, Die Heliceen, Berlin, p. 202 [type species, *Pupa mumia* Bruguière, v. Martens 1861, subsequent designation; *non Strophia* Meigen 1825; Stål 1877].

Strophiops Dall: 1894, Bull. Mus. Comp. Zool., **25**, p. 121 [type species, *Pupa decumana* Férussac, original designation].

stroutii Maynard and Clapp, *Strophiops:* 1920, Records, App., **10**, p. 120, pl. 21, figs. 1-2 (Little Strout [Shroud]; Strout [Shroud]; East and West Hawksbill and Cistern Keys [Exuma Group] Bahamas).

stupida Maynard and Clapp, *Strophiops:* Records, App., **10**, p. 135, pl. 33, figs. 1-2 (North Key, Staniard Creek, Andros, Bahamas).

subcostulatum Aguayo and Sánchez Roig, *Cerion herrerai:* 1953, Memorias, **21**, p. 287, pl. 32, fig. 3 (northern part of Cayo Santa Maria, Caibarién [Las Villas] Cuba).

subcylindrica Beck, *Pupa uva:* 1837, Index Molluscorum, p. 82, [see note under *bidens* Beck].

sublaevigatum "Pfeiffer" Pilsbry and Vanatta, *Cerion* (*Maynardia*): 1895, Proc. ANSP, p. 209 (Matanzas, Cuba).

submarmoratum Pilsbry and Vanatta, *Cerion:* 1897, Proc. ANSP, **49**, p. 365, text figs. 3-4 ([Fortune Id.] Bahamas). Is *C. fordii* P. and V., Clench 1938.

sucyrasi "Blanes" Pilsbry and Vanatta, *Cerion:* 1898 [1899], Proc. ANSP, p. 477, text fig. 6 (Vita, Cuba).

sula Maynard and Clapp, *Strophiops:* 1915, Records, App., **6**, p. 180 [new name for *obliterata* Maynard 1913, not *obliterata* Maynard 1896].

sulcata "Lamarck" Sowerby, *Pupa:* 1834, The Genera of Recent and Fossil Shells, pt. 41, figs. 3-4 (no locality). Is *C. mumia* Bruguière, Pilsbry 1902.

swiftii Pilsbry and Vanatta, *Cerion regina:* 1895, Proc. ANSP, p. 208 (Turks Island [Bahamas]). Is *C. regina* P. and V., here considered a synonym.

sylvatica Maynard and Clapp, *Strophiops:* 1921, Records, App., **10**, p. 137, pl. 34, fig. 7-8 (Chub Point Key, Berry Islands, Bahamas).

tabida Maynard, *Strophiops:* 1913, Records, App., **5**, p. 199 (near Cur-

rent Settlement, Eleuthera, Bahamas). Is *C. hyattii* Mayn., Clench 1952.

tanamensis Sánchez Roig, *Cerion:* 1951, Revista, **7**, p. 120, pl. 19, fig. 1 (Punta de Piedra, Yaguaeque, Sagua de Tánamo, Cuba).

tantillum Aguayo and Jaume, *Cerion gundlachi:* 1951, Revista, **8**, p. 5, pl. 2, fig. 11 (Cayo Guillermo, north of Punta Alegre, Camagüey, Cuba).

tejedori Sánchez Roig, *Cerion:* 1951, Revista, **7**, p. 112, pl. 18, fig. 7 (Punta Arenas, Paso de las Carabelas, Peninsula de Sabinal, Camagüey, Cuba). Is *C. sanzi* P. and V. See notes, this report.

tenuicostata Maynard and Clapp, *Strophiops:* 1920, Records, App., **10**, p. 121, pl. 4, figs. 3, 9 (Sampson's Cay [Stanyard Cay, 3½ miles NW of Great Guana Cay, Exuma Group] Bahamas).

tenui Maynard and Clapp, *Strophiops:* 1915, Records, App., **6**, p. 182 (east end of New Providence, Bahamas).

tenuicallum Aguayo and Sánchez Roig, *Cerion circumscriptum:* 1953, Memorias, **21**, p. 288, pl. 32, fig. 17 (Cayo Francés, Caibarién, Las Villas, Cuba). Is *C. sanzi* P. and V. See notes, this report.

tennilabris "Gundlach" Pfeiffer, *Pupa:* 1870, Malakozoologische Blätter, **17**, p. 91 (Barigua, Mata [Baracoa] Cuba).

territa Maynard and Clapp, *Strophiops:* 1921, Records, App., **10**, p. 147, pl. 15, fig. 2; pl. 43, figs. 3-4 (Methodist Churchyard, Nassau, New Providence, Bahamas).

thayeri Maynard and Clapp, *Strophiops:* 1921, Records, App., **10**, p. 137, pl. 34, figs. 5-6 (east end of Thompson's Key, Berry Islands, Bahamas).

thompsoni Maynard and Clapp, *Strophiops:* 1915, Records, App., **6**, p. 179 (south shore of Hog Island, New Providence, Bahamas).

thorndikei Maynard, *Strophia:* 1894, Contributions, **2**, p. 116, fig. 34 (Cemetery between Waterloo and Nassau, New Providence, Bahamas). Is *C. varium* Bonnet, Pilsbry 1902.

tibida Maynard, *Strophiops:* 1921, Records, App., **10**, p. 152 [error for *tabida* Maynard].

torrei "Blanes" Pilsbry and Vanatta, *Cerion:* 1898 [1899] Proc. ANSP, p. 476, text figs. 1-2 (Port of Vita, Cuba).

tortuga Pilsbry and Vanatta, *Cerion:* 1928, Proc. ANSP, **80**, p. 476, pl. 27, figs. 15-17 (Tortuga Island, Haiti).

tracta Maynard, *Strophia cinerea:* 1894, Contributions, **2**, p. 123, fig. 37 (eastern point of Hog Island, New Providence, Bahamas). Is *C. varium* Bonnet, Pilsbry 1902.

transitoria Maynard, *Strophiops:* 1913, Records, App., **5**, p. 194 (northern portion of Great Pimlico Island [Eleuthera] Bahamas). Is *C. uniforme* Mayn., Clench 1952.

transmutata Maynard and Clapp, *Strophiops:* 1921, Records, App., **10**, p. 127, pl. 26, figs. 1-2 (Muddy Point Key, Great Exuma, Bahamas).

travelii Maynard and Clapp, *Strophiops:* 1921, Records, App., **10**, p. 135, pl. 32, figs. 3-4 (Bridgewater Key, Berry Islands, Bahamas).

tridentatum Pilsbry and Vanatta, *Cerion* (*Paracerion*): 1895, Proc. ANSP, p. 206; *ibid*, 1896, p. 336, pl. 11, fig. 27 (Cuba [Rincón de Guanabo, Habana, Cuba]).

Tridentistrophia Maynard: 1896, Contributions, **3**, p. 9 [type species, *Strophia striatella* Férussac, original designation]. Is a synonym of *Paracerion* Pilsbry and Vanatta.

tumida Sowerby, *Pupa:* 1876, Conchologica Iconica, **20**, pl. 1, fig. 6 (Cuba) [a MS name changed to *incrassata*].

tumidula Deshayes, *Pupa:* 1851, Deshayes [in] Férussac, Histoire Naturelle Générale et Particulière des Mollusques, **2**, pt. 2, p. 207 (Cuba) [is *C. mumia* Bruguière].

turgidum Torre and Welch, *Cerion ramsdeni:* 1934, Nautilus, **47**, p. 106, pl. 11, fig. 3a-d (hill west of Toro River, 1 km. from beach or "Ojo del Toro" west of Ensenada de Mora, Oriente, Cuba).

turnerae Clench and Aguayo, *Cerion* (*Umbonis*): 1952, Occ. Papers on Mollusks, **1**, no. 17, p. 423, pl. 53, figs. 4-7 (Lydia Point, Great Inagua, Bahama Islands).

typica "Pfeiffer" Pilsbry, *Cerion maritimum:* 1902, M. of C., (2) **14**, p. 213 [*nomen nudum*]. This was not intended to be a name introduced by Pfeiffer but only a descriptive term.

ultima Maynard, *Strophiops:* 1913, Records, App., **5**, p. 190 (Southwest Key, New Providence, Bahamas).

Umbonis Maynard: 1896, Contributions, **3**, p. 28 [type species, *Strophia scalarina* Pfeiffer and Gundlach, monotypic].

uniformis Maynard, *Strophiops:* 1913, Records, App., **5**, p. 194 (Little Pimlico Island [Eleuthera] Bahamas).

universa Maynard, *Strophiops:* 1913, Records, App., **5**, p. 196, (fossil, Green Key [Rose Island, New Providence] Bahamas). Is *C. uniforme* Mayn., Clench 1952.

utowana Clench, *Cerion* (*Strophiops*): 1933, Proc. New England Zool. Club, **13**, p. 92, pl. 1, figs. 1-2 (East Plana Key, Bahamas).

utriculus Menke, *Pupa:* 1829, Verzeichnis Conchy. Samml. Malsburg, Pyrmont, p. 8 (locality not given).

uva Linné, *Turbo:* 1758, Systema Naturae, ed. 10, p. 765, (locality unknown [Curaçao]). [Refers to Gualtieri 1742, Index Testarum, pl. 58, fig. D].

vaccinum Pilsbry, *Cerion incanum:* 1902, M. of C., (2) **14**, p. 215, pl. 29, fig. 51 (east end of Key Vaccas [Vaca] Florida).

vagabunda Maynard and Clapp, *Strophiops:* 1925, Records, App., **10**, pl. 41, figs. 7-8 (southern end of Rose Island, New Providence, Bahamas). [New name for *albata* Maynard and Clapp July 1921, not *albata* Maynard and Clapp May 1921].

valdesi de la Torre, *Cerion ceiba:* 1954, Revista, **9,** p. 43, pl. 5, fig. 5 (Abra Ventura, east of Canasí, Matanzas, Cuba).

valida Maynard and Clapp, *Strophiops:* 1920, Records, App., **10,** p. 124, pl. 22, figs. 1-2 (near well on west coast of Ship Channel Key [Exuma Group] Bahamas).

valida Pilsbry and Vanatta, *Cerion* (*Maynardia*) *columna:* 1895, Proc. ANSP, **47,** p. 207 (Inagua [Bahamas]).

valleí Aguayo and Jaume, *Cerion vulneratum:* 1951, Revista, **8,** p. 2, pl. 2, fig. 7 (north coast of Cayo Puerco, bay of Puerto Padre, Oriente, Cuba).

vanattai Clench and Aguayo, *Cerion:* 1951, Revista, **8,** p. 78, pl. 11, fig. 12 (Playa Larga, Boca de Jauco, Baracoa, Oriente, Cuba).

vannostrandi Pilsbry and Vanatta, *Cerion ritchiei:* 1896, Proc. ANSP, p. 323 (locality unknown).

varius Bonnet, *Pupa:* 1846, Revue et Magasin de Zoologie (2) **16,** p. 71, pl. 6, figs. 3-4 (Tasmania [New Providence, Bahamas]).

variabile Dall, *Cerion* (*Strophiops*): 1905, Smithsonian Misc. Collect., **47,** p. 440, pl. 58, fig. 6 (Red Bay, NW end of Andros Island, Bahamas).

varia-nivia Maynard, *Strophiops:* 1913, Records, App., **5,** p. 186 (Eastern Cemetery, Sherley St. to St. Paul quarry, Nassau, New Providence, Bahamas).

varia-purpurea Maynard, *Strophiops:* 1913, Records, App., **5,** p. 188 (Bay St., east to Creek Settlement, Nassau, New Providence, Bahamas).

varia-thorndikei Maynard, *Strophiops:* 1913, Records, App., **5,** p. 186 (Cemetery east of Nassau, New Providence, Bahamas).

variata Maynard and Clapp, *Strophiops:* 1921, Records, App., **10,** p. 134, pl. 32, figs. 1-2 (Crab Key, Berry Islands, Bahamas).

variegata Pfeiffer, *Pupa incana:* 1868, Monographia Heliceorum Viventium, **6,** p. 289 [based upon W. G. Binney 1859, Terrestrial Air-Breathing Mollusks of the United States, **4,** pl. 70 [79], fig. 17 (Florida)]. Is *C. incanum* Binney, Pilsbry 1902.

variegata Küster, *Pupa rubicunda:* 1844, Conchylien-Cabinet, (2) **1,** pt. 15, p. 76 (West Indies [Great Inagua, Bahamas]).

ventricosior Beck, *Pupa uva:* 1837, Index Molluscorum, p. 82 [see note under *bidens* Beck].

venusta Poey, *Pupa:* 1858, Memorias sobre la Historia Natural de la Isla de Cuba, **2,** p. 30 (Cuba).

vermiculum Dall, *Cerion oweni:* 1905, Smithsonian Misc. Collect., **47,** p. 443, pl. 58, fig. 3 (Mathews Point, south side of Great Abaco, Bahamas). Is *C. bendalli* P. and V., Clench 1938a.

veta Maynard and Clapp, *Strophiops:* 1920, Records, App., **10,** p. 120, pl. 21, figs. 3-4 (fossil, Strout's [Stroud] Key, [Exuma Group] Bahamas).

vetusta Maynard, *Strophiops:* 1913, Records, App., **5,** p. 191 (fossil, Silver Keys of Nassau bar, Nassau, New Providence, and Pimlico Keys, Eleuthera, Bahamas). Is *C. inconsuetum* Mayn., Clench 1952.

vetusta-praedevina Maynard, *Strophiops:* 1913, Records, App., **5,** p. 195 (fossil, Great Pimlico Key, [Eleuthera] Bahamas). Is *C. inconsuetum* Mayn., Clench 1952.

viaregis Bartsch, *Cerion:* 1920, Carnegie Institution of Washington, **14,** no. 282, p. 13, pl. 5; figs. 7-31 (King's Road, Bastian Point, northeast side of South Bight, Andros Island, Bahamas).

victor de la Torre, *Cerion:* 1929, Nautilus, **42,** pl. 4, figs. 12-13 [no description] (Caleta de Ovando, Oriente, Cuba).

viola Maynard, *Strophia:* 1890, Contributions, **1,** pl. 16, fig. 5a-b [no description] (no locality given but Inagua, Bahamas on original label).

vulgare Röding, *Cerion:* 1798, Museum Boltenianum, (2) p. 90, refers to Knorr, **6,** pl. 25, fig. 4 (no locality). [Is *C. uva* Linné.]

vulnerata Küster, *Pupa:* 1855, Conchylien-Cabinet, (2) **1,** pt. 15, p. 161, pl. 19, figs. 16-18 (locality unknown [Oriente, Cuba]).

watlingense Dall, *Cerion* (*Strophiops*): 1907, Smithsonian Misc. Collect., **47,** p. 438, pl. 58, fig. 7 (Watling Island, Bahamas).

weinlandi "Kurr." v. Martens, *Pupa:* 1860, Malakozoologische Blätter, **6,** p. 207, pl. 2, fig. 1, (Crooked Island, Bahamas).

wrighti Aguayo and Sánchez Roig, *Cerion mumia:* 1953, Memorias, **21,** p. 284, pl. 32, fig. 5 (Cuba; Charles Wright. [Northern coast of Pinar del Río, Cuba]).

yumaensis Pilsbry and Vanatta, *Cerion* (*Maynardia*): 1895, Proc. ANSP, p. 210 (Yuma River, Haiti [Santo Domingo]).

zebra "Weinland" Sowerby, *Pupa:* 1875, Conchologia Iconica, **20,** *Pupa* p. 12, fig. 12a-b (Bahamas).

REFERENCES

CLENCH, W. J.

1938. Origin of the Land and Freshwater Mollusk Fauna of the Bahamas, With a List of the Species Occurring on Cat and Little San Salvador Islands. Bull. Mus. Comp. Zool., **80:** 481-541, 3 plates.

CLENCH, W. J.

1938a. Land and Freshwater Mollusks of Grand Bahama and the Abaco Islands, Bahama Islands. Mem. Soc. Cubana Hist. Nat., **12:** 303-333, 2 plates.

CLENCH, W. J.

1942. Land Shells of the Bimini Islands, Bahama Islands. Proc. New England Zool. Club, **19:** 53-67.

CLENCH, W. J.

1952. Land and Freshwater Mollusks of Eleuthera Island, Bahama Islands. Rev. Soc. Malacologica "Carlos de la Torre," **8:** 97-116, 3 plates.

CLENCH, W. J. and C. G. AGUAYO
1952. The Scalarinum Species Complex (Umbonis) in the Genus *Cerion*. Occasional Papers on Mollusks, Harvard University, 1: 413-440, 7 plates.

KÜSTER, H. C.
1841- Conchylien-Cabinet, 1, pt. 15: 1-96, 9 plates.
1847.

MAYNARD, C. J.
1889- Contributions to Science, Newtonville, Mass. Vols. 1-3.
1896.

MAYNARD, C. J.
1913- Appendices to Records of Walks and Talks with Nature, West
1926. Newton, Mass. Vols. 5, 6, and 10.

MAYNARD, C. J.
1924. Catalogue of Specimens of the Family Cerionidae for Sale by C. J. Maynard, West Newton, Mass., pp. 1-6.

PILSBRY, H. A.
1901- Manual of Conchology, (2) 14: 174-286, 21 plates.
1902.

PILSBRY, H. A.
1943. Note on *Cerion striatellum* ("Fér." Guérin). Nautilus, 57: 34-35.

PILSBRY, H. A.
1946. Land Mollusca of North America. Academy of Natural Sciences Philadelphia, Monographs 3, 2, pt. 1: 158-169, 5 text figures.

PLATE, L.
1907. Die Variabilität und die Artbildung nach dem Prinzip geographischer Formenketten bei den Cerion-Land Schnecken der Bahama-Inseln. Archiv für Rassen- und Gesellschafts-Biologie, 4: 433-614, 5 plates.

SMITH, E. A.
1898. On the Land-Shells of Curaçoa and the Neighbouring Islands. Proc. Malacological Soc. London, 3: 113-116, 2 text-figures.

SOWERBY, G. B.
1875- Conchologia Iconica, 20, *Pupa*, text and 3 plates.
1876.

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Zoology Department, Victoria University College, Wellington, New Zealand

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No. 3 — *Studies on New Zealand Elasmobranchii. Part VI. Two New Species of* Etmopterus *from New Zealand* [1]

By J. A. F. Garrick

Zoology Department, Victoria University College, Wellington, New Zealand

Experimental line-fishing off New Zealand, for the purpose of adding to our knowledge of the deeper-water shark fauna of this region, has resulted in the capture of three specimens of *Etmopterus* representing two species apparently new to science. These specimens were caught off Kaikoura on the east coast of the South Island, by Mr. Richard Baxter, who, fishing from a 16 foot dinghy, collected one large brown specimen from 500 fathoms, and a small grey-black specimen from 200 fathoms in November, 1955. In February, 1956, a further grey-black specimen was caught in 100 fathoms. All captures were made close inshore, the submarine topography of the Kaikoura region being such that water 500 fathoms deep is found within 3 miles of the coast.

Although squaloid sharks are fairly well represented in the New Zealand fauna, no specimens of *Etmopterus* have been known, and geographically the nearest member of the genus is *E. molleri* (Whitley) 1939 of southern Australia. It is therefore of considerable interest that the two species of these luminescent sharks now known to be present should represent what are more or less the extremes of morphological diversity in the genus. The large brown specimen, here proposed as *Etmopterus baxteri* n.sp., in honour of Mr. Richard Baxter, is akin to *E. princeps* of the North Atlantic in its size — which exceeds that of most other species; in the uniform but random arrangement of the dermal denticles; in the noticeably small and rounded pectoral fins; in the rather plain colouration and inconspicuous pelvic flank mark; and in the high number of cusps on the upper teeth. The grey-black specimens, named here as *Etmopterus abernethyi* n.sp., for Mr. Fred Abernethy who has contributed greatly to the collection of New Zealand elasmobranchs, are closely allied to the Pacific species *E. lucifer, E. brachyurus* and *E. molleri*, and like them are small; with dermal denticles arranged linearly

[1] This study has been assisted by a grant from the Research Grants Committee of the University of New Zealand.

on the sides and upper surface of the trunk; with large and more angular pectoral fins; with an obvious colour pattern and conspicuous flank marks; and with a smaller number of cusps on the upper teeth.

Comparison of *E. baxteri* and *E. abernethyi* with other species of the genus, of which twelve are listed by Bigelow, Schroeder and Springer (1953, p. 238), though *E. molleri* (Whitley) 1939 should be added to these, has been greatly facilitated by the availability of specimens of *E. spinax, E. polli* and *E. princeps* provided by Drs. H. B. Bigelow and W. C. Schroeder, to whom I am also especially indebted for their generosity in supplying access to their manuscript key to the species.

Etmopterus baxteri n.sp.

Figures 1 and 2

Study Material. Holotype, mature female, 742 mm. total length, Dominion Museum No. 1950, lined from 500 fathoms seven miles south of Kaikoura, New Zealand, by Mr. R. Baxter, in November, 1955.

Description. Proportional measurements in per cent of total length:

Trunk at pectoral origin : breadth, 12.7 ; height, 10.8

Snout length in front of : outer nostrils, 1.7 ; mouth, 8.4.

Eye : horizontal diameter, 4.0 ; vertical diameter, 2.7.

Mouth : breadth, 8.4 ; height, 1.4.

Nostrils : breadth (between inner corners), 3.1.

Labial furrow lengths : upper, 3.5 ; lower, 1.7.

Gill-opening lengths : 1st., 2.7 ; 3rd., 1.7 ; 5th., 1.7.

First dorsal fin : vertical height, 3.1 ; length of base, 5.7.

Second dorsal fin : vertical height, 4.0 ; length of base, 8.1.

Caudal fin : upper margin, 18.4 ; lower anterior margin, 10.2.

Pectoral fin : anterior margin, 7.5 ; width, 6.1.

Pelvic fin : anterior margin, 5.7 ; distal margin, 6.2 ; posterior margin, 2.2.

Distance from snout to : eye, 5.4 ; 1st gill-opening, 16.2 ; 5th gill-opening, 20.7 ; 1st dorsal, 33.4 ; 2nd dorsal, 65.5 ; upper caudal, 81.8 ; pectoral, 21.7 ; pelvic, 57.4.

Interspace between : 1st and 2nd dorsals, 26.0 ; 2nd dorsal and

caudal, 10.1; pelvic and subcaudal, 14.3.

Distance from origin to origin of: pectoral and pelvic, 35.7; pelvic and subcaudal, 22.2.

Head depressed, wide, compact, and very large-eyed; trunk moderately stout, and compressed posterior to the pectorals. Height of trunk at origin of pectorals 7.5 in the length from snout tip to origin of subcaudal. Length of body measured to the cloaca, 62 per cent of the total length. Caudal peduncle little compressed and slender, and without lateral keels or precaudal pits.

Dermal denticles small, numerous, and in the form of conical thorns, slightly curved and directed posteriorly, and borne on four-angled bases. Each denticle carries six ridges, four of which are continuous with the ridges arising from the angles of the base, while two are intermediate ridges on the anterior face of the denticle and do not extend on to the base. Denticles from the head and fins similar to those from the trunk. The denticles are distributed uniformly but sparsely so that there are considerable interspaces between them where the skin is visible. Their arrangement is random, at least on the anterior two-thirds of the trunk, though towards the caudal peduncle and on the tail they are in more or less regular longitudinal rows. The pectoral, pelvic, dorsal and caudal fins are denticle covered almost to their margins, except for the ventral surface of the pelvic which has a wide, naked zone distally, and the web of the second dorsal on which the denticles are very sparse. Other naked regions of the body include the ventral surface of the tip of the snout; the upper and lower lips; the axil of the pectoral where the naked area is large and ovoid in outline, extending along the trunk well posterior to the fin when the latter is laid back, and also continued on to the upper surface of the fin itself as a wide band along the posterior margin; the axil of the pelvic and the entire upper surface of the base of this fin; the axil of the first dorsal where the naked area is small; and the axil of the second dorsal where the naked area is very extensive, reaching from in front of the origin of the fin to behind its posterior free tip. In all cases, the naked regions correspond with the lighter coloured areas on the trunk and fins. Within the dark area encompassed by the pelvic flank mark, the denticles are noticeably smaller

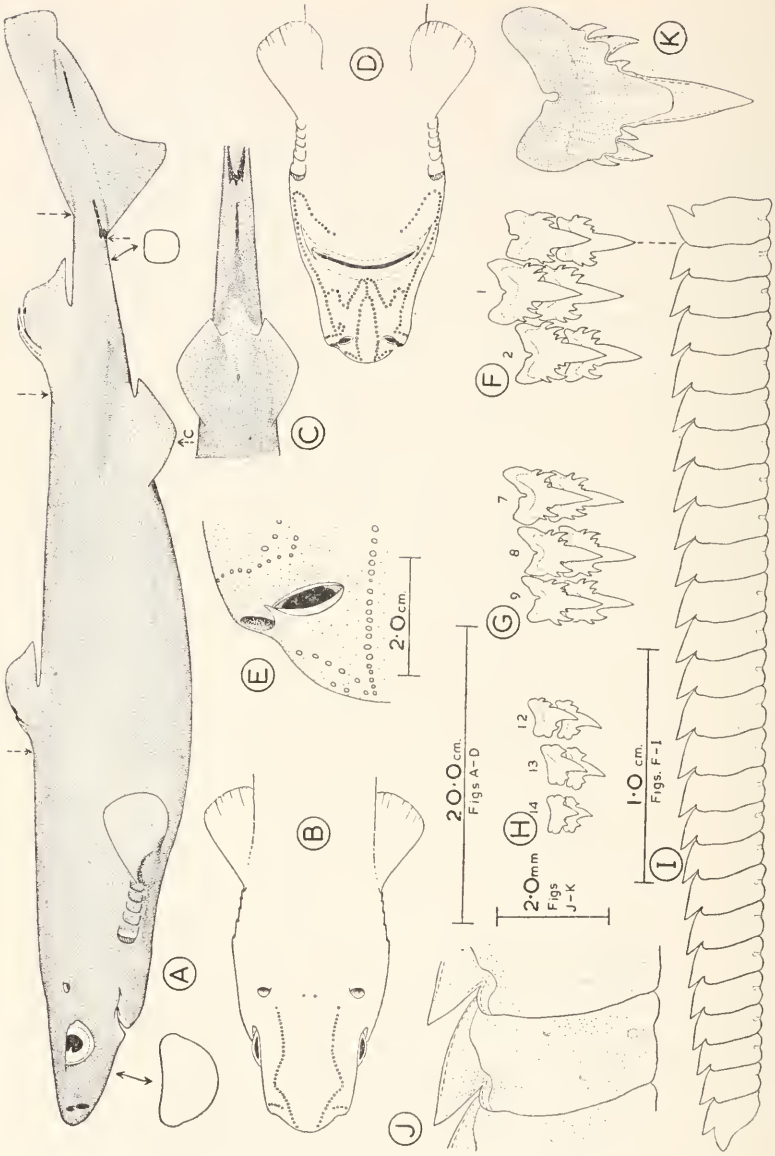

Figure 1. *Etmopterus baxteri* n.sp., holotype, 742 mm. total length. *A*, lateral view and insets of sections through snout and peduncle; *B*, dorsal view of head showing prominent lateral line pores; *C*, ventral view of peduncle; *D*, ventral view of head with pores as in *B*; *E*, left nostril; *F-H*, upper teeth from right side, row numbers indicated above; *I*, lower teeth, right side; *J*, 10th lower tooth, right side; *K*, 6th upper tooth, right side. (*c* = level of cloaca.)

than the adjacent ones, and also the tips of these denticles are directed ventrally rather than posteriorly as are the majority of the trunk denticles.

Head measured to first gill-opening 6.2 in the total length, and just less than half the distance from snout tip to first dorsal origin. Head noticeably broad, its greatest width at the level of the first gill-opening where it is 1.6 times the least fleshy interorbital width, the latter being equal to the preoral distance. Width of the head at the level of the nostrils is only slightly narrower than the interorbital width, so that the contours of the head between these levels are almost parallel. The snout tip is broadly rounded, and each nostril forms an abrupt step in the contour. The snout is thick, slightly wedge-shaped in profile, strongly depressed, and flat above as is the greater part of the head to the level of the spiracles. Length of snout measured to eye, 3.0 in the head. Eye very large, ovoid, 1.5 times as long as high, its horizontal diameter 1.3 in the snout. Spiracle large, its length 4.0 in the horizontal diameter of the eye, and placed just above the level of the dorsal margin of the eye, and behind it by a distance equal to about twice its own length. Gill-openings of moderate size and slightly oblique; each gill-opening is deeply emarginate, especially the first in which the tips of the gill-filaments are visible. Lengths of the gill-openings decrease from the first to the fourth, but with the fifth equal to the third. Length of the first gill-opening 1.7 times that of the fourth, and 1.5 in the horizontal diameter of the eye. Interspaces between the gill-openings decrease posteriorly, that between the first and second almost twice that between the fourth and fifth. Nostrils large, oblique, and well anterior on the venter of the snout. Each nasal aperture subdivided into an anteriorly directed, circular, anterolateral aperture and an ovoid posteromedial aperture by triangular nasal flaps. The anterior nasal flap is large, pointed, and external to the shorter, fleshy posterior flap. The posteromedial aperture is also margined in front and behind by a low membrane. Mouth broad, and only slightly arched, its width just greater than the preoral distance, and 1.9 in the length of head. The upper labial furrows moderately long, and deeply incised anteriorly, their length 1.4 in the distance from their anterior extremity to the symphysis of the upper jaw. The lower labial

furrows are shallowly incised and short, their length about half that of the upper furrows.

Teeth $\frac{14\text{–}1\text{–}14}{25\text{–}27}$, dissimilar in the two jaws. The upper teeth erect, each with a long, sharply-pointed, awl-shaped, smooth-edged major cusp flanked on each side by up to four small lesser cusps, and borne on a longitudinally-striated bifid base. Most of the upper teeth have three lesser cusps on each side of the major cusp, with the middle cusp of these three considerably larger than the others though not more than one-third the length of the major cusp. A few teeth near the centre of the jaw have four lesser cusps on each side, with the largest lesser cusp separated from the major cusp by two small lesser cusps, while in the teeth towards the angle of the jaw there is a reduction in the number of lesser cusps to one or two on each side. Three series of upper teeth functional at the centre of the jaw, two towards the angles. The lower teeth blade-like, each with a smooth, little-sculptured, rectangular base almost twice as high as broad, and bearing a single, smooth-edged, triangular cusp. Each cusp is sharply notched laterally, strongly oblique, and overlaps the adjacent cusp so that an almost continuous cutting edge is formed. There is no median tooth, and the base of the first tooth on the left side overlaps that of the first tooth on the right. A single series of lower teeth functional.

First dorsal small, short-based, and brush-shaped, its distance from snout tip 33.4 per cent of the total length. Height of first dorsal 1.9 in its base, and the latter 4.6 in the interspace between the first and second dorsals. Length of the posterior margin 1.5 in the length of the base; the posterior tip sharply pointed. The first dorsal spine short and almost straight, its length less than half the distance from its origin to the first dorsal apex. Interspace between the first and second dorsals equal to the distance from snout tip to the axil of the pectoral. Second dorsal considerably larger than the first, and originating above the posterior insertion of the pelvic base. Height of the second dorsal 2.0 in its base, and the latter 3.2 in the interspace between the dorsals. The second dorsal spine strongly curved and long, its length 2.5 times that of the first dorsal spine. Interspace between second dorsal and caudal 3.0 in that between first and second dorsals. Caudal measured from hypural origin 5.0 in

the total length. Height of the epiural 4.6 in its length, and its margin slightly sinuous. The terminal lobe with a convex margin. Height of the hypural 1.7 times that of the epiural, and its lower anterior margin almost straight. The apex acutely angled, and the posterior margin deeply concave. The pectorals short and wide, their length 2.0 in the head measured to the first gill-opening, and their width 1.4 in their length. The anterior margin almost straight, the posterior margin slightly convex and continued without a distinct angle into the distal margin. Pelvics originating anterior to the second dorsal origin by a distance equal to the length of the pectoral. Length of pelvic base equal to that of second dorsal base; posterior margin short, its length 2.5 in the horizontal diameter of the eye. The posterior tip of pelvic pointed, and terminating just anterior to the origin of the second dorsal spine.

Figure 2. *Etmopterus baxteri* n.sp., holotype, 742 mm. total length. *A*, external view of dermal denticles from high on side at level of 1st dorsal; *B*, lateral view.

Colour. The overall colour of the specimen is an almost uniform, medium dusky brown, slightly darker on the ventral surface and on the fins, but considerably lighter in the regions which are smooth and free of denticles, such as the axils of the fins, and the lips. There is also a vertical white band devoid of pigment on the anterior surface of the outer part of each gill-arch, though this is visible only on the first arch where the anterior edge of the first gill-opening is strongly emarginate. Despite the ap-

parent uniformity of colour of the specimen, close examination reveals the presence of well-defined, darker regions which contribute to a pattern similar to that described for other etmopterids. These darker regions are characterised in this specimen chiefly by the presence of numerous small, black pits, rather than by an increase in the number of typical chromatophores. The black pits are not, however, confined to the darker regions, but are distributed more sparsely over the entire head, trunk and fins. The most prominent dark region is a longitudinal flank mark above the pelvic fin, and of the shape shown in Figure 1A. As described above, within the area encompassed by this flank mark, the dermal denticles are smaller and directed more ventrally than those outside it, so that they also contribute to its definition. The pelvic flank marks are connected on the ventral surface of the caudal peduncle where they form a pattern as in Figure 1C. The ventral surface of the abdomen is also a distinct dark region, well delineated on the flanks by a denser concentration of black pits along its edges than elsewhere on the ventral surface. Anteriorly it is continued under the head and snout, but apart from an ill-defined transverse band under the head, its extent is not clear. Other dark marks present are a narrow, curved band on the lower surface of the pectoral fin, extending from the origin of the fin to its insertion; a short streak on the anterior margin of each dorsal fin, close to the tip of each dorsal spine; and a prominent, dark line near the tip of the caudal axis, parallel to and just below the terminal portion of the lateral line where the latter is in the form of a naked groove. The last-mentioned mark is contributed to not only by black pits, but also by a very thin black streak along each edge of the lateral line groove. A very few similar black streaks are also present sporadically on the sides of the trunk, where they are short and appear to be derived from the fusion of contiguous black pits. The lining of the mouth is a light dusky brown, as is the lining of the body cavity.

Luminescence. The black pits which contribute most of the colour pattern to the specimen, and the few black streaks which are present, appear to be identical with those of *E. spinax* in which they are known to be luminescent. However, Mr. Baxter did not notice any luminescence on the specimen when it was

first taken from the water, though this was during daytime when such luminescence might not be obvious.

Maturity. The adult condition of the specimen is evidenced by the extrusion of two embryos during its transport from Kaikoura to Wellington. The embryos are two inches long, devoid of pigment, and only part way through development. They were attached to large yolk-sacs, though these were ruptured and could not be measured. At least two other intact yolk-sacs can be felt within the animal, and possibly others may be present but ruptured.

Discussion. The thorn-like denticles of *E. baxteri* readily distinguish it from those species of *Etmopterus* with truncate denticles, i.e. *frontimaculatus, pusillus* and *granulosus,* as they do also from *paessleri* which is described as having denticles with a larger central spine surrounded by several lesser spines. Of the remaining etmopterids, all of which have denticles with a single spine, four more are separable from *baxteri* on denticle characters — namely, *virens,* in which the denticles are thorn-like but very short and low, and *spinax, hillianus* and *schultzi,* which have elongate, bristle-like denticles; though as the differences between these species and *baxteri* in this respect are less distinctive than those between *baxteri* and the species with truncate or multispinose denticles mentioned above, it is perhaps better not to rely on them alone as primary specific characters.

Compared with *virens, baxteri* is heavy-bodied and short-tailed (the distance from pelvic origin to tip of caudal 42.6 per cent of the total length in *baxteri,* 53 per cent in *virens*). From *villosus, baxteri* differs in the very much shorter predorsal length (equal to less than the distance from origin to origin of the first and second dorsals in *baxteri,* but reaching from first dorsal origin to almost the upper caudal origin in *villosus*). The two noticeably short-tailed Pacific species, *brachyurus* from the Philippines and *molleri* from southern Australia, differ from *baxteri* not only in their short-tailedness (the length of the upper caudal margin two-thirds and three-fourths of the distance from the rear ends of the pelvic bases to the lower caudal origin in *brachyurus* and *molleri* respectively, but more than one and a third times in *baxteri*) but also in the linear arrangement of the denticles on the sides of their trunks; their proportionately longer pectoral fins (reaching to the first dorsal when laid back

in *brachyurus* and *molleri*, but falling well short of this level in *baxteri*) ; and their more attenuate pelvic flank marks. The same differences apply between *lucifer* and *baxteri,* though in *lucifer* the length of the upper caudal margin is proportionately longer than in *brachyurus* or *molleri* but still considerably shorter than in *baxteri.*

Of the etmopterids with bristle-like denticles, i.e. *schultzi, hillianus* and *spinax*, *schultzi* is clearly distinct from *baxteri* not only in its very elongate caudal fin (the upper margin of the caudal almost equal to the distance from snout tip to the tip of the pectoral when the latter is laid back in *schultzi,* but reaching only to the second gill-opening in *baxteri*) but also in its peculiar frayed and fringe-like fin margins which differ from those of all other etmopterids. *E. hillianus* has a greater peduncular length than *baxteri* (the distance from the rear ends of the pelvic bases to the lower caudal origin as long as the distance from snout tip to pectoral origin in *hillianus,* but reaching only midway between spiracle and first gill-opening in *baxteri*) ; while *spinax* is readily separable from *baxteri* by its much narrower head (head width equal to the preoral distance in *spinax*, but more than one and a half times this distance in *baxteri*) ; its shorter and less concave gill-openings ; and the shape of the dark markings on the ventral surface of the trunk and peduncle.

The remaining etmopterids to be compared with *baxteri,* i.e. *polli* and *princeps*, both agree with this species in being more or less plain and dark coloured, and in having thorn-like denticles which are in random but uniform arrangement. *E. polli,* however, is distinctive in having a short interdorsal space (reaching much less than the distance from snout tip to first gill-opening in *polli,* but extending to the axil of the pectoral in *baxteri*) and a longer pectoral which reaches behind the base of the first dorsal spine when laid back. In *baxteri* and *princeps* the pectorals are short, their tips failing to reach the first dorsal origin, while further agreement between these species is seen in the noticeable broadness of the head, the long and concave gill-openings (which expose the lamellae of the first gill-arches), and the vertical white markings on the outer part of the gill-arches.

E. baxteri differs from *princeps* in having a shorter tail (the length from pelvic origin to tip of caudal equal to distance from

snout tip to posterior tip of the first dorsal fin in *baxteri*, but reaching to midway between first dorsal tip and pelvic origin in *princeps*) ; a shorter caudal fin (the upper caudal margin reaching from snout to second gill-opening in *baxteri* but from snout tip to pectoral origin in *princeps*) ; a more conspicuous and differently shaped pelvic flank mark; less oblique nostrils; and upper teeth mostly with 7 or 9 cusps rather than the 5 cusps in *princeps*. Moreover the arrangement of the lesser cusps of the upper teeth in *baxteri*, where a very small lesser cusp is sandwiched between a larger lesser cusp and the major cusp, differs from that in not only *princeps* but also all other etmopterids where the lesser cusps usually diminish uniformly in size from the major cusp outwards.

Etmopterus abernethyi n.sp.

Figures 3 and 4

Study Material. Holotype, immature male, 338 mm. total length, Dominion Museum No. 1951 ; and paratype, female, 278 mm. total length, Mus. Comp. Zool. No. 39714; both lined by Mr. Richard Baxter from 7 miles south of Kaikoura, the holotype from 200 fathoms in November, 1955, the paratype from 100 fathoms in February, 1956.

Description. Proportional measurements in per cent of total length: Holotype and paratype.

Trunk at pectoral origin : breadth, 10.4-11.1 ; height, 8.6-8.6.

Snout length in front of : outer nostrils, 2.7-2.5 ; mouth, 10.9-11.5.

Eye : horizontal diameter, 4.6-5.0 ; vertical diameter, 2.7-2.9.

Mouth : breadth, 5.9-6.1 ; height, 1.2-1.1.

Nostrils : breadth (between inner corners), 3.0-3.2

Labial furrow lengths : upper, 3.3-3.2 ; lower, 1.5-1.4.

Gill-opening lengths : 1st, 1.3-1.3 ; 5th, 1.0-1.1.

First dorsal fin : vertical height, 3.3-4.0 ; length of base, 5.6-6.5.

Second dorsal fin ; vertical height, 5.6-6.1 ; length of base, 8.0-8.6.

Caudal fin : upper margin, 22.5-23 0 ; lower anterior margin, 10.9-10.4.

Pectoral fin : anterior margin, 9.5-9.7 ; width, 8.3-9.3

Pelvic fin : anterior margin, 7.1-6.8 ; distal margin, 6.8-9.0.

Distance from snout to : eye 6.5-7.2 ; 1st gill-opening, 18.7-19.0 ; 5th gill-opening, 21.9-23.0 ; 1st dorsal, 29.6-32.0 ; 2nd dorsal, 57.0-57.9 ; upper caudal, 77.5-77.0 ; pectoral, 22.2-23.4 ; pelvic, 48.2-49.4.

Interspace between : 1st and 2nd dorsals, 21.6-19.8 ; 2nd dorsal and caudal, 12.7-11.9.

Distance from origin to origin of : pectoral and pelvic, 26.3-27.1 ; pelvic and subcaudal 27.1-26.3.

Head depressed, long, and very large-eyed ; trunk moderately slender, and compressed posterior to the pectorals. Height of trunk at origin of pectorals 8.7 in the length from snout tip to origin of subcaudal. Length of body measured to the cloaca, 53 per cent of the total length. Caudal peduncle little compressed and slender, and without lateral keels or precaudal pits.

Dermal denticles small, slender and thorn-like, borne on four-angled bases and with their tips directed slightly posteriorly. Each denticle is six-ridged, as in *E. baxteri,* though the ridges are less steep and fail to extend to the tip of the denticle. The denticles are numerous, and well-spaced ; arranged in random on the ventral surface of the head and trunk, but in distinct parallel longitudinal rows on the sides and upper surface, the fins, and the venter of the peduncle. Above the lateral line, the rows are oblique, sloping posterodorsally on the head and in front of the first dorsal fin, but with their slope flattening out and reversing behind the latter level. Below the lateral line, the rows are horizontal. The line of demarcation between the linear arrangement of the denticles on the sides and the random arrangement below, is sharp, and parallels that of the dark colour pattern ; it skirts the lateral margin of the snout, follows round the lower edge of the eye, runs beneath the gill-openings, and is especially prominent from the axil of the pectoral to the origin of the pelvic. Within the lateral pelvic flank mark, the denticles are more sparsely distributed, are noticeably smaller, and have their tips directed ventrally rather than posteriorly. The distal parts of the webs of the dorsal, pectoral and pelvic fins are naked, as are the terminal and hypural lobes of the caudal fin. Other naked areas include the upper and lower lips ; the interspaces between the gill-openings ; and the axils of the pectoral, pelvic and dorsal fins (though none of the latter is as extensive as in *E. baxteri*).

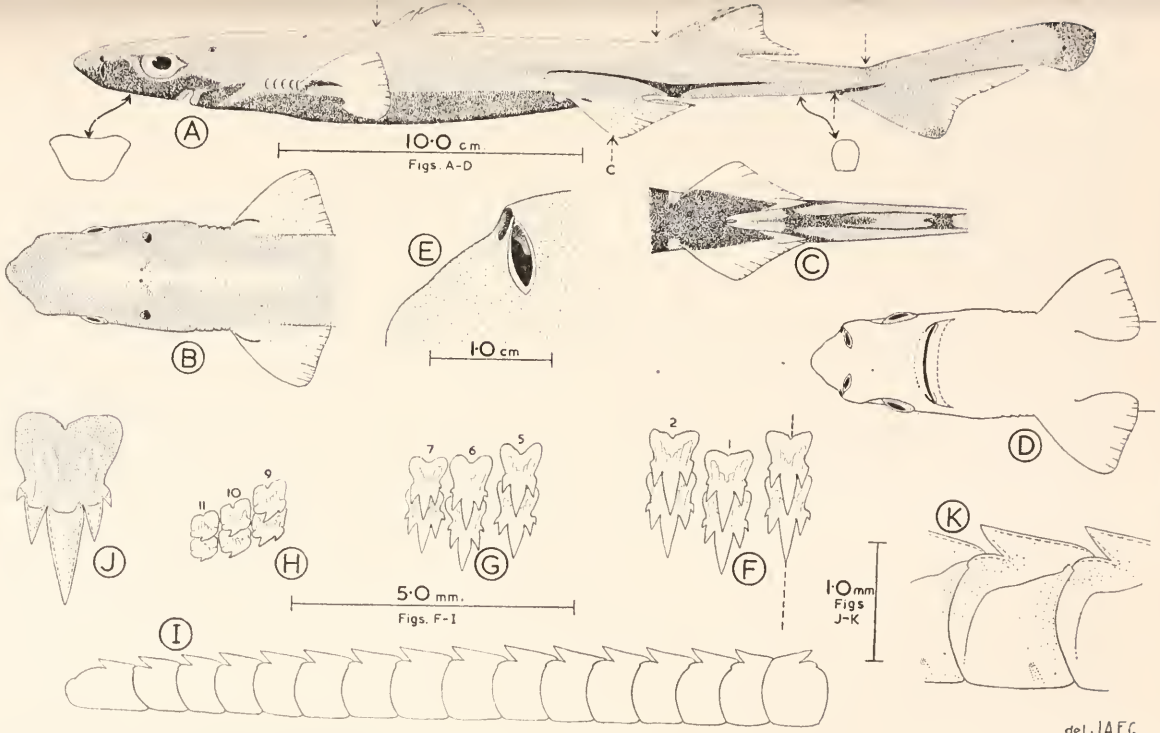

Figure 3. *Etmopterus abernethyi* n.sp., holotype, 338 mm. total length. *A*, lateral view and insets of sections through snout and peduncle; *B*, dorsal view of head showing extensive pale regions; *C*, ventral view of peduncle; *D*, ventral view of head; *E*, left nostril; *F-K*, paratype, 278 mm. total length; *F-H*, upper teeth from right side, row numbers indicated above; *I*, lower teeth from right side; *J*, 3rd upper tooth, right side; *K*, 4th lower tooth, right side. (*c* = level of cloaca.)

Head measured to first gill-opening 5.3 in the total length, and about two-thirds of the distance from snout tip to first dorsal origin. Head long, flat above, and with little change in width from the level of the spiracles to the level of the nostrils. Interorbital width 1.4 in the preoral distance. The snout contours rapidly taper at the level of the nostrils so that the snout tip is prominently pointed. In lateral view the snout is of almost equal thickness from the hind level of the eyes to the nostrils, though anterior to the latter the profile angles steepen to form the bluntly wedge-shaped snout tip. Length of snout, measured to eye, 2.9 in the head. Eye large, ovoid, nearly twice as long as high; its horizontal diameter 1.4 in the snout. Spiracle large, its length just less than one quarter of the horizontal diameter of the eye, and placed just above the eye and behind it by a distance equal to one and a half times its own length. Gill-openings small, each vertical but concave, their lengths subequal and about 4.0 in the eye. Interspaces between the gill-openings decrease slightly posteriorly. Nostrils large, oblique, and well anterior on the venter of the snout. Each nasal aperture subdivided by triangular nasal flaps into a circular, anterolateral aperture facing to the anterior, and an ovoid posteromedial aperture which is margined in front and behind by a low membrane. The anterior nasal flap is attenuate, sharply pointed, and external to the short fleshy posterior flap. Mouth broad and little arched, its width 1.5 in the preoral distance, the latter 1.7 in the head. The upper labial furrows deeply incised anteriorly, their length equal to the distance from their anterior extremities to the symphysis of the upper jaw, and arranged so that one-third is anterior to the angle of the jaw and two-thirds is posterior. The lower labial furrows are shallowly incised and short, their length less than half that of the upper furrows.

Teeth $\frac{11\text{–}1\text{–}11}{18\text{–}17}$ in the male of 338 mm., $\frac{10\text{–}1\text{–}11}{16\text{–}15}$ in the female of 278 mm., dissimilar in the two jaws. The upper teeth erect, multicusped, each with a long, sharply-pointed, awl-shaped, smooth-edged major cusp flanked on each side by one or two lesser cusps, and borne on a longitudinally-striated base. Most of the upper teeth have two lesser cusps on each side of the major cusp, with the outer cusp of these two very much smaller than the inner which is one-third to one-half of the length of the major cusp.

The teeth towards the angle of the jaw have only one or no lesser cusps on each side. Three series of upper teeth functional at the centre of the jaw, two towards the angles. The lower teeth blade-like, each with a smooth-faced, subrectangular, laterally-rounded base, bearing a single, smooth-edged triangular cusp. Each cusp is sharply notched laterally, very strongly oblique, and overlaps the adjacent cusp so that an almost continuous cutting edge is formed. There is no median tooth, and the base of the first tooth on the left side overlaps that of the first tooth on the right. A single series of lower teeth functional.

First dorsal small, brush-shaped, originating just anterior to the tip of the pectoral when the latter is laid back. Distance from snout tip to first dorsal origin 29.6 per cent to 32.0 per cent of the total length. Height of first dorsal 1.7 in its base, and the latter 3.8 in the interspace between the first and second dorsals. Length of the posterior margin 1.3 in the length of the base, and the posterior tip pointed. The first dorsal spine short and almost straight, its length less than half the distance from its origin to the apex of the fin. Interspace between the dorsals equal to or less than the distance from snout tip to pectoral origin. Second dorsal much larger than the first, originating just posterior to the rear insertion of the pelvic base. Height of the second dorsal 1.5 in its base, and the latter 2.7 in the interspace between the dorsals. The second dorsal spine curved and long, reaching two-thirds of the distance from its origin to the apex. Interspace between second dorsal and caudal 1.8 in that between first and second dorsals. Caudal measured from hypural origin 4.0 in the total length. Height of the epiural 6.5 in its length, and its margin straight along most of its length but convex distally. The terminal lobe with a convex margin. Hypural originates well anterior to the epiural, its height 1.6 times that of the latter. Anterior margin of hypural straight, the apex right-angled but rounded, and the posterior margin concave. Pectorals noticeably wide, their width 1.2 in their length, and the latter 2.3 in the head. Anterior and posterior margins convex, distal margin straight, and the posterior angle smoothly rounded. Pelvics originating well anterior to the second dorsal, the interspace between first dorsal tip and pelvic origin equal to the length of the pelvic base. Anterior and distal margin straight, and the apex prominent but rounded.

The posterior tip sharply pointed and terminating at the level of the second dorsal spine. Claspers on holotype cylindrical in section, tapering to a point posteriorly, and showing no sign of the external features which might be expected in a mature animal.

Colour. Dusky dark brown above, black below, though a heavy coating of mucus gives the specimens a greyish cast. Dorsal, pectoral and pelvic fins pale and translucent, as is the lower posterior margin of the caudal. A large, ovoidal pale area covers the greater part of the top of the head, and posteriorly is continued as a wide band along the mid-dorsum of the trunk and peduncle, though it is interrupted at the dorsal fins, the bases of which are dusky brown. There is also a pale supraorbital streak on each side of the head; a narrow indistinct pale band along the lateral line; and an elongate pale mark above and anterior to the pelvic origin. In the female of 278 mm., the pale markings are more extensive than in the holotype; the mid-dorsal band extending well down the sides of the peduncle, and the epiural lobe as well as the hypural lobe is pale, though the terminal lobe and the apex of the hypural are darker than elsewhere on the caudal axis as is also the case in the holotype.

Microscopic examination shows that the darkness of the ventral surface is due not only to a greater number of chromatophores compared with the condition on the sides and upper surface, but also to the presence of numerous small black pits, as in *E. baxteri*. The dark regions thus characterised include the undersurface of the snout, head and trunk (the demarcation line between the dark region below and the lighter region above well delineated by a greater concentration of black pits than elsewhere on the undersurface — see Figure 4C); the venter of the peduncle where a pattern is present as in Figure 3C, though this pattern is not developed as clearly in the female of 278 mm.; an attenuate pelvic flank mark of the shape shown in Figure 3A; a long, narrow caudal streak parallel to and below the naked, grooved portion of the lateral line; a large curved streak on the underside of the pectoral, and a short arc on its upper surface; and a short streak on the upper surface of the pelvic base. There is also a prominent row of black pits and streaks along the mid-dorsal line, while others are scattered over most of the head and the

trunk where their concentration and arrangement is similar to that known in *E. lucifer*. Lining of mouth dusky grey; lining of body cavity black.

Luminescence. It is not known if *E. abernethyi* is luminescent, for although the black pits and streaks present resemble closely those of luminescent species of *Etmopterus*, no luminescence was observed in the specimens when they were caught.

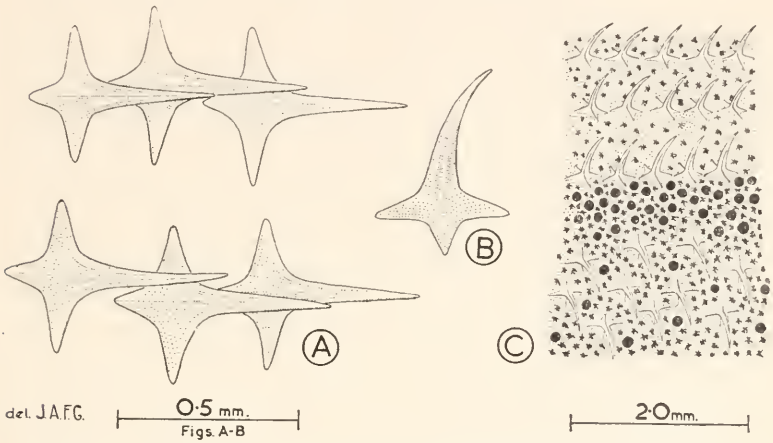

Figure 4. *Etmopterus abernethyi* n.sp., holotype, 338 mm. total length. *A*, external view of denticles from high on side at level of 1st dorsal; *B*, lateral view; *C*, external view of skin from lower part of side of trunk, showing three rows of denticles arranged linearly, and others below arranged at random. Note greater concentration of chromatophores in lower half, and black pits which are most numerous at demarcation line between light and dark regions.

Maturity. The claspers on the holotype lack the external spurs which might be expected in a mature specimen; the female of 278 mm. has not been examined for its state of maturity though its small size in comparison with the immature male suggests that it, too, is immature.

Discussion. As in *E. baxteri*, the thorn-like denticles of *E. abernethyi* provide a ready character for the separation of this species from *frontimaculatus, pusillus* and *granulosus* which have truncate denticles, and from *paessleri* in which the denticles are

multispinose. The slender thorns of *abernethyi* are also obviously distinct from the short, low denticles of *virens,* though in other respects including the general proportions of the body, *abernethyi* is strikingly similar to this species. It differs from *virens* in the relatively shorter peduncular length (the distance from the rear ends of the pelvic bases to the lower caudal origin equal to the distance from snout tip to first gill-opening in *abernethyi,* but reaching to the pectoral origin in *virens*); in the lack of the transverse pale markings on the abdomen; in the presence of the conspicuous mid-dorsal pale band; and in the shape of the dark pelvic flank mark and the ventral peduncular dark marks. *E. abernethyi* differs from *villosus* in the much shorter predorsal length (just greater than the distance from origin to origin of the first and second dorsals in *abernethyi,* but reaching from first dorsal origin to almost the upper caudal origin in *villosus*).

The etmopterids with bristle-like denticles differ less from *abernethyi* in their denticle shape than they do from *baxteri* which has shorter and less slender denticles than *abernethyi.* But *schultzi* with its very elongate caudal (the upper margin of which is about equal to the distance from snout tip to tip of pectoral when the latter is laid back) and its fringed fins cannot be confused with *abernethyi* whose upper caudal margin is just greater than the length of head measured to the pectoral and whose fins are not frayed more than is usual in other etmopterids. *E. hillianus* differs from *abernethyi* not only in its bristle-like denticles, as does *spinax,* but also in its greater peduncular length (distance from rear ends of bases of pelvics to origin of lower caudal equal to distance from snout tip to pectoral origin in *hillianus,* but only to first gill-opening in *abernethyi*); the shape of the pelvic flank mark and the ventral peduncular mark; and the prepelvic transverse pale band which is lacking in *abernethyi. E. spinax* has a peduncular length similar to *abernethyi,* but differs in its random arrangement of bristle-like denticles, and its colour patterns including the shape and extent of the pelvic and peduncular dark marks.

E. polli, princeps and *baxteri* have denticles only slightly stouter than those of *abernethyi,* but like *spinax,* these are arranged in random (at least anterior to the caudal peduncle) and thus markedly different to the linear arrangement in *abernethyi.*

The pelvic flank marks of *polli* and *baxteri* are much less elongate than those of *abernethyi,* while the short interdorsal space of *polli* (equal to less than the distance from snout tip to first gill-opening in *polli,* but extending to the pectoral origin in *abernethyi*) and the short stubby pectoral fins of *princeps* and *baxteri* (failing to reach the first dorsal origin when laid back) clearly distinguish these species from *abernethyi.*

The remaining three etmopterids, *brachyurus, molleri* and *lucifer,* all agree fairly closely with *abernethyi* in their overall proportions, their colour patterns (excluding the extensive mid-dorsal pale band which seems to be characteristic of *abernethyi*), and the nature and arrangement of their denticles. But *brachyurus* and *molleri* are short-tailed species, the lengths of their upper caudal margins reaching only two-thirds and three-fourths of the distance from the rear ends of the pelvic bases to the lower caudal origins, while in *abernethyi* the upper caudal margin is one and a quarter times this distance. Moreover, in lateral view both *brachyurus* and *molleri* are noticeably more sharp-snouted species, the upper and lower profiles of the head tapering smoothly to the snout tip. *E. abernethyi* is less sharp-snouted, the head profiles little tapered from the eyes to the nostrils but steepening rapidly from the nostrils anteriorly, where a distinct change in the angles is evident. *E. lucifer* is intermediate between *abernethyi,* and *brachyurus* and *molleri* in the length of its upper caudal margin (which is equal to the distance from the rear ends of pelvic bases to the origin of lower caudal), but differs from *abernethyi* in having a greater peduncular length (distance from rear ends of pelvic bases to origin of lower caudal equal to distance from snout tip to pectoral origin in *lucifer,* but reaching only to first gill-opening in *abernethyi*); a shorter snout (equal to or less than the length of the eye in *lucifer,* but 1.5 times the eye-length in *abernethyi*); a different dark pattern on the undersurface of the peduncle; and the lack of the extensive mid-dorsal pale band which is so prominent in *abernethyi.*

LITERATURE CITED

BIGELOW, H. B., W. C. SCHROEDER, AND S. SPRINGER
1953. New and little known sharks from the Atlantic and from the Gulf of Mexico. Bull. Mus. Comp. Zool., **109** (3): 213-276, figs. 1-10.

WHITLEY, G.
1939. Studies in ichthyology no. 12. Rec. Australian Mus., **20** (4): 264-277.

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BIOLOGICAL INVESTIGATIONS IN THE SELVA LACANDONA, CHIAPAS, MEXICO

Raymond A. Paynter, Jr., Editor

With One Plate

CAMBRIDGE, MASS., U. S. A.
PRINTED FOR THE MUSEUM
April, 1957

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No. 4 — Biological Investigations in the Selva Lacandona, Chiapas, Mexico

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I

INTRODUCTION

By

Raymond A. Paynter, Jr.

In northeastern Chiapas, bordered on one side by the Río Usumacinta and on the other by the Río Jataté, with northern limits near Palenque and southern limits along the Guatemalan border, there is a vast area of about 15,000 square kilometers of almost unexplored and very sparsely inhabited virgin forest (Map). The region is known as the Selva Lacandona, because of the presence of scattered family groups of Lacandon Indians, primitive and isolated remnants of the once vast Maya empire.

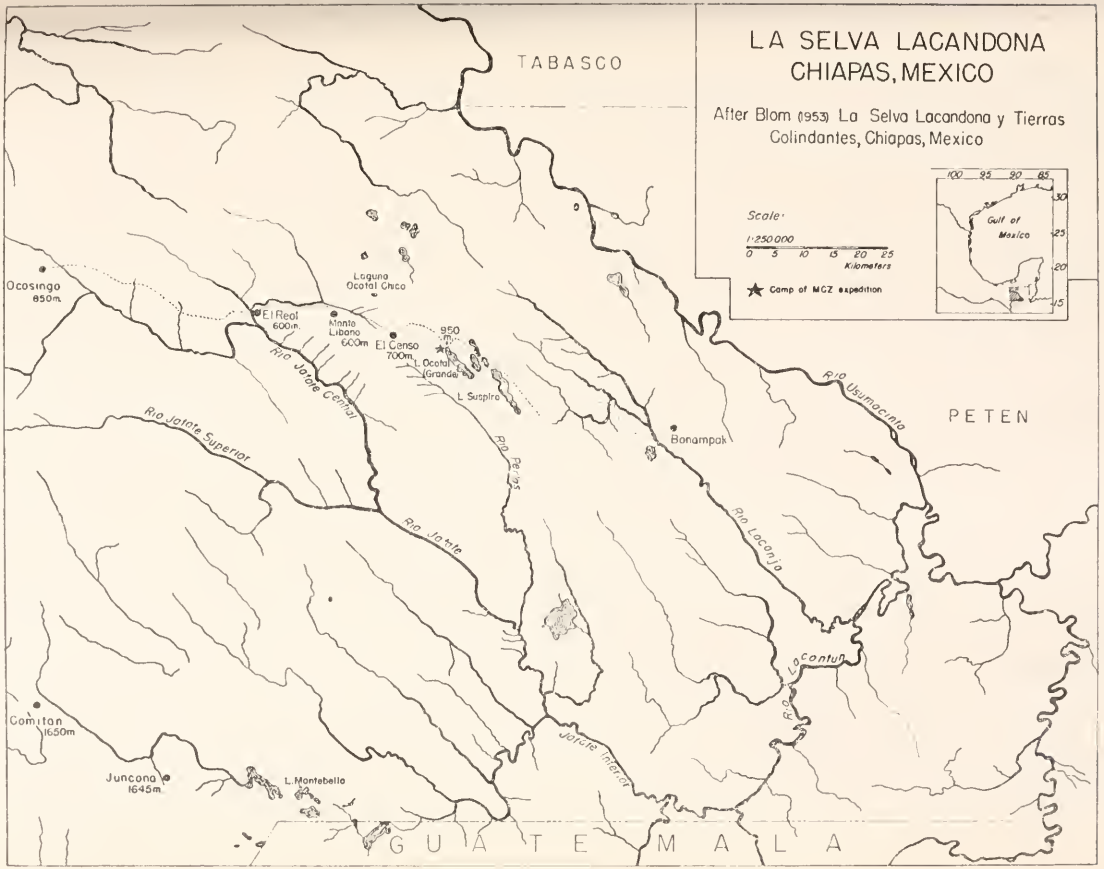
The Indians, who number less than 200 individuals, have been the subject of considerable publicity over the past decade, particularly after the discovery at Bonampak of well-preserved murals in some ruined temples which are occasionally utilized by the Lacandons. Several expeditions of archaeologists and an-

thropologists have been into the Selva Lacandona (see, e.g., Blom and Duby, 1955), principally in the vicinity of Bonampak, but no biologists have reconnoitered the region, with the exception of the Goodnights (1953), who studied the Phalangids, and Miranda (1953), who made a botanical survey. Both investigations were made at Monte Líbano, on the edge of the forest, and probably are only indications of what occurs in the interior.

The Selva Lacandona is on the northeastern slope of the central highlands of Chiapas. There is a gradual decline in altitude from a maximum of approximately 1400 meters, near the Río Jataté, to about 100 meters, at the Río Usumacinta. Between the two principal rivers are many lesser streams whose courses are very poorly known, but which generally parallel one another in a northwest-southeast direction. Scattered throughout are a number of sizable lakes (*lagunas*), the largest of which are Laguna Suspiro and Laguna Ocotal Grande (Plate, upper figure), nine and seven kilometers in length, respectively. The natives call the latter lake simply "Laguna Ocotal," and all the zoological material obtained there was so labeled, but on a map prepared by Frans Blom (see Map) the longer name is used, in contradistinction to Laguna Ocotal Chico, a much smaller lake to the northeast.

It is unfortunate that nothing certain is known of the drainage of these important lakes. While they may drain southeast into the Río Lacanjá, thence into the Río Lacantun, and finally into the Usumacinta basin, there is no evidence that this is the case, despite the predilections of cartographers for drawing connecting streams between known lakes and known rivers. From personal observations, limited to the region about Laguna Ocotal, I am inclined to believe that these lakes have formed within closed-end solution valleys. The heavily karsted limestone strongly suggests such an origin. Underground drainage to the Usumacinta basin is possible, of course.

Miranda (1952) has prepared a generalized vegetation map of Chiapas in which the Selva Lacandona is depicted as being covered by high evergreen forest, with areas of pines and oaks at the lakes and along the southwestern boundary of the region. It should be realized, however, that "high evergreen forest" is a broad term embracing a great diversity of vegetational assem-


LA SELVA LACANDONA
CHIAPAS, MEXICO
After Blom (1953) La Selva Lacandona y Tierras Colindantes, Chiapas, Mexico
Scale:
1:250000
0 5 10 15 20 25
Kilometers
Camp of MCZ expedition
Gulf of Mexico
TABASCO
PETEN
GUATEMALA
Ocosingo 850m.
El Real 600m.
Monte Libano 600m.
El Censo 700m.
Laguna Ocotal Chico
950 m.
L. Ocotal Grande
L. Suspiro
Río Jataté Central
Río Jataté Superior
Río Jataté
Río Perlas
Río Usumacinta
Río Lacanja
Río Lacantun
Bonampak
Comitan 1650m.
Juncona 1645m.
L. Montebello
Jataté Inferior

blages. For example, at Monte Líbano the forest is high, luxuriant, and has a relatively clear understory. It is what is usually referred to as "rain forest," which in this part of the world commonly contains, among other characteristic species, mahogany (*Swietenia humilis*) and *ramón* (*Trophis racemosa* or *Brosimum alicastrum*). On the other hand, at Laguna Ocotal there is a forest which seems physiognomically quite similar but which is markedly different in composition, lacking, in part, *ramón* and mahogany, while gigantic oaks (*Quercus* spp.) are present. A detailed description of the vegetation about Laguna Ocotal is found in Dressler's account (pp. 200-203).

Nothing is known of the climatology of the region. Since the altitude and vegetation vary in the Selva Lacandona, it is reasonable to suppose that the climate is also variable. The nearest location from which weather records are available is Tenosique, Tabasco, a town at a somewhat lower elevation (60 m.) than the lowest point in the Selva Lacandona. Here the mean annual rainfall is 1697 mm., with June being the wettest month and March the driest; the warmest month is May, which has a mean temperature of 30.4°C. and the coolest month is January, with a mean of 22.9°C. (Ward and Brooks, 1936).

In 1954, with generous support from the American Academy of Arts and Sciences and from the Chapman Memorial Fund of the American Museum of Natural History, a party was formed in order to make the first biological survey of the interior of the Selva Lacandona. The group consisted of the author, as leader and ornithologist, Robert T. Paine, 3rd, as assistant ornithologist, Elisha F. Lee, as mammalogist, Robert L. Dressler, as botanist, and Mrs. Ruth Oberg, also a botanist, specializing in the Orchidaceae.

In early July the party flew from the capital of Chiapas, Tuxtla Gutiérrez, to Ocosingo (alt. 850 m.), a village about one hundred kilometers to the northeast. Heavy rains had raised the level of the nearby rivers and delayed for several days the arrival of our pack animals. Finally, on the morning of July 10 we started for Finca El Real (alt. 600 m.), which is approximately 40 kilometers to the east, and reached there in the afternoon of the following day.

At El Real additional supplies, mules, and men were secured and on July 15, with 18 mules and 9 *arrieros,* trail-cutters, etc.,

we moved 20 kilometers east to the settlement of Monte Líbano (alt. 600 m.). During the night a number of the mules strayed and we were unable to recover them and move on until July 18. The trail-cutters had been sent ahead to clear the way and prepare bridges, but progress was slow and difficult owing to the mud and obstructions in the trail. About seven hours after leaving Monte Líbano we arrived at El Censo (alt. 700 m.), an uninhabited camping spot in magnificent rain forest. The following morning the trail was poor during the first hour of travel, but then became worse due to an escarpment which rises over 300 meters above the country to the east. Ascent was made by steep switchbacks which were barely surmounted by the pack animals. Beyond this point the trail improved somewhat. In the middle of the afternoon our destination was reached and a camp was prepared at the northwestern end of Laguna Ocotal (Plate, lower figure), at an altitude of 950 meters. Because of insufficient forage at the lake, most of the mules were returned to El Real, but four men remained to assist with the collecting and maintenance of the camp.

The forest is dense and the terrain rough around Laguna Ocotal, which means that it is seldom practicable to work far from a trail. The only trails existing in the area are the one by which we entered, and a badly obstructed path leading to Bonampak. Consequently, we were not able to range as far as desired and even after a month of intensive collecting did not reach the opposite end of the lake or the pine-covered ridges along its southwestern side. Future workers in the region would do well to employ an additional man or two to cut new trails, thereby enabling the collectors to sample a larger area.

The campsite was situated on a narrow strip of ground which has cut off a small arm of the lake, impounding the water and forming a swamp. Most of the mammals, and many of the amphibians were collected here.

Although each member of the party concentrated on his field of interest, unrelated material was collected whenever possible. For this reason the bird, mammal, and botanical[1] collections are probably the most nearly representative samples from the region, while the fish, reptile, amphibian, and inverte-

[1] No complete report on the botanical collections has been prepared. A list of the Orchidaceae has been compiled by Mrs. Ruth Oberg (in press).

brate collections contain, in the main, only the more conspicuous elements of their faunas.

At the end of a month the mules were brought back from the ranch and on August 20 the camp was abandoned. We returned to El Real by the same route used in entering the forest and on August 30 were flown from the ranch to Tuxtla Gutiérrez.

An especial debt of gratitude is owed to the members of the field party. Their whole-hearted cooperation is evident from the large amount of material which was collected, although the period was brief and conditions difficult. During preparations, and while in the field, we received much assistance and many courtesies from Horacio Albores of Ocosingo, José Tárano and Juan Bulnes of Finca El Real, and Frans Blom of San Cristóbal de las Casas. I wish, also, to express my appreciation to Joseph C. Bequaert, Charles H. Blake, William L. Brown, Jr., Frances L. Burnett, Robert L. Dressler, Charles P. Lyman, Robert Rush Miller, and Benjamin Shreve, who have submitted the following reports based on material obtained during the expedition.

LITERATURE CITED

Blom, Frans and Gertrude Duby

1955. La Selva Lacandona. Mexico, D.F. Editorial Cultura, 448 pp.

Goodnight, Clarence J. and Marie L. Goodnight

1953. The Opilionid Fauna of Chiapas, Mexico and Adjacent Areas (Arachnoidea, Opiliones). Amer. Mus. Novit., No. 1610, 81 pp.

Miranda, Faustino

1952. La Vegetación de Chiapas, Parte I. Tuxtla Gutiérrez, Chiapas, Dept. de Prensa y Turismo, 334 pp.

1953. Un Botánico en el Borde de la Selva Lacandona. Mem. Congreso Cient. Mex., **6**: 285-303.

Oberg, Ruth

[In press]. Orchids Collected at Laguna Ocotal Grande, Mexico. Orchid Jour., **3**.

Ward, Robert DeC. and Charles F. Brooks

1936. The Climates of North America. Pt. I. Mexico, United States, Alaska. *In* Handbuch der Klimatologie. II. Amerika. Teil J (1 Lief.), 325 pp.

The northern end of Laguna Ocotal. The pine-covered ridges parallel the southwestern shore of the lake.

Photo by Lee

A small hill covered by pines projects from a low deciduous forest (*monte:* see Dressler, pp. 200) near the campsite at Laguna Ocotal. The lofty tropical evergreen forest begins behind the hill and is not visible.

Photo by Lee

II

THE VEGETATION ABOUT LAGUNA OCOTAL

By

Robert L. Dressler[1]

Only a preliminary characterization of the plant cover can be made at this time. Many important species were not in flower or fruit, and the upper stories of the rich tropical evergreen forest were sampled only through occasional windfalls.

Four main vegetation types may be recognized in the area: (1) Pine Forest, or *ocotal*, which is usually at a higher level on a given slope than is *monte* or *selva*, but occurs down to the lake shore near the campsite. Pine forest is said to extend southward for some distance on the ridge west of the lakes. (2) *Monte*, a dense transition of small, usually slender, hardwoods. This vegetation generally occurs between the *ocotal* and the *selva* or the lake shore. (3) Tropical Evergreen Forest (*selva*). This, the "*montaña*" of the natives, makes up the bulk of the Selva Lacandona of eastern Chiapas and apparently surrounds the lake area. (4) Cloud Scrub, a distinctive type limited to promontories overlooking the lake.

(1) Pine Forest. The pine stands include some splendid, large specimens of *Pinus tenuifolia* Bentham (probably the only species present), but are not continuous or very extensive in the area studied. The pines probably occupy only slopes and hilltops which are too well drained for the more mesic forest types. Open park-like sites, which are few and quite small, have a grassy ground cover including *Cyperus*, *Scleria*, *Dichromena*, and *Panicum*. In favored sites an understory is formed by small hardwood trees, such as *Hauya heydeana* Donnell-Smith, a reddish-barked tree with much the aspect of *madroño*, *Saurauia subalpina* Donnell-Smith, and *Myrica cerifera* L. These trees are often quite mossy and bear a rich epiphyte flora of many species of orchids and ferns, most of which also occur in the upper stories of the *selva*. The pines themselves bear many epiphytes, but these are of relatively few species, the genera *Tillandsia*,

[1] Gray Herbarium, Harvard University, Cambridge, Massachusetts.

Catopsis, and *Epidendrum* being conspicuous. *Chimaphila maculata* (L.) Pursh was found on one slope, and a small fan-palm (*Brahea*) occurs in dry sites. The greater part of the pine forest has a great deal of undergrowth and might be considered as a marginal type passing into the *monte*.

(2) Transition Forest or *Monte*. This is a somewhat diverse assemblage of vegetations which is characterized by its relatively low height (mostly about 5-10 m.) and great density, its position between the pine forest and the *selva*, and a very poor epiphyte flora. Only a few of the trees making up this vegetation have been identified. A pink-fruited *Hoffmannia* is frequent, *Acalypha gummifera* Lundell and *Cnidoscolus multilobus* (Pax) Johnston are local, and *Cecropia* was observed in one stand. A slender *Verbesina* and *Calliandra houstoniana* (Miller) Standley are frequent in drier sites. Undergrowth is relatively scant in most parts of the *monte*, but the shrubby *Cephaelis tomentosa* (Aublet) Vahl is abundant on the *selva* side of the transition, and the fern, *Nephrolepis cordifolia* (L.) Presl, is locally very abundant on the *ocotal* side.

This vegetation may, on an abrupt slope, form a very narrow zone, or it may be more widespread. In one or two sites near the camp it is fairly extensive in small areas that have been disturbed (cut over for fire wood and poles for camp construction, burnt over, and doubtless heavily grazed by mules at infrequent intervals). At the north end of the lake clear evidence of disturbance is found in a nearly pure stand of small "*pomarosa*", *Eugenia* (*Syzygium*) *jambos* L. (which may be considered a local phase of the *monte*). This Asiatic species is certainly introduced. There are two or three very large examples of *pomarosa* and two large clumps of bamboo near the Bonampak trail, which may date to its original introduction. On a slope nearby, in the *ocotal*, there is a small area where *Lantana camara* L., *Trema micrantha* (L.) Blume, *Euphorbia hirta* L., and *Psidium* (probably *P. guajava* L.) occur together. None of these weedy species was seen elsewhere in the region, and they surely indicate past disturbance. Many of the elements of the *monte* are probably those that would occur in secondary growth anywhere in the area (for example, *Cnidoscolus*, *Cecropia*).

(3) Tropical Evergreen Forest or *Selva*. This is the *Selva Alta Siempre Verde* of Miranda (1952). I have used "*selva*" rather than the local "*montaña*" in my notes and discussion to avoid confusion with "*monte*". This fine forest is similar to (and continuous with) that near Monte Líbano, which has been described by Miranda (1953b), though the forest about Laguna Ocotal lacks chicozapote, ramón, mahogany, and the fiendishly spiny palm, *Hexopetion*. Ground cover in the *selva* is relatively sparse and walking about is easy. Fallen fruits and flowers indicate that *Talauma mexicana* (de Candolle) Don and *Cymbopetalum penduliflorum* (Dunal) Baillon are frequent, and the fruits of *Sloanea* were seen at one place. Oaks (*Quercus Skinneri* Bentham and perhaps other species) occur frequently, especially in the drier phases of the *selva*. These slightly more open, less humid stands, curiously enough, are not to be found near the drier *ocotal*, but at some distance from the lake, along the Bonampak trail. The *selva* adjoining the *ocotal* (or transition) usually shows its wetter phases. The upper stories of the *selva* are rich in epiphytes of many kinds. The lower tree trunks bear ferns, peperomias, gesneriads and a few species of orchids (such as *Chondrorhyncha lendyana* Reichenbach fil., *Pleurothallis cardiothallis* Reichenbach fil., *Maxillaria malcolcus* Schlechter, and *M. nasuta* Reichenbach fil.) which are largely or quite restricted to this habitat. *Collinia*, *Eleutheropetalum*, and several species of *Chamaedorea* were the only palms seen in the *selva;* tree ferns (*Cyathea*) are locally abundant.

(4) Cloud Scrub. This vegetation, probably comparable to the "elfin woodland" of the West Indies, was found only on cliff tops overlooking the west side of the lake (the prevailing winds are from the east, across the water). These local and relatively inaccessible sites were not visited by the expedition zoologists. The limestone promontories are very well drained and, probably for this reason, support only relatively small trees (predominantly *Clusia rosea* Jacquin?), but, while the arboreus elements are comparable in size and form to *monte bajo* or chaparral, the great atmospheric moisture supports an abundance of epiphytes. These epiphytes are largely mosses and ferns, but some orchids, *Ericaceae* and other epiphytes of the high *selva* also flourish in the *Clusia* scrub.

These collections and notes are too scanty and our knowledge of the Lacandon Forest, as a whole, too slight to say much about the geographic affinities of the Laguna Ocotal region. A number of the expected "Guatemalan" and "Honduran" species, new to the known flora of Mexico, were found, especially in the rich orchid flora (Oberg, in press). The pine forest itself is relatively poor in distinctive elements, but this is perhaps to be expected from its small and discontinuous area. It is possible that this *ocotal* has lost ground to the *monte* in relatively recent times through the occasional disturbances caused by chicleros, anthropologists, and others who have used this campsite on the Bonampak trail. A more long-term vegetational change may be indicated by the pine logs found in *selva* near Monte Líbano (Miranda 1953b).

LITERATURE CITED

Miranda, Faustino

1952. La Vegetación de Chiapas. Parte I. Tuxtla Gutiérrez, Chiapas, Dept. de Prensa y Turismo, 334 p.

1953a. La Vegetación de Chiapas. Parte II. Tuxtla Gutiérrez, Chiapas, Dept. de Prensa y Turismo. 426 p.

1953b. Un Botánico en el Borde de la Selva Lacandona. Mem. Congreso Cient. Mex., **6**: 285-303.

Oberg, Ruth

[In press.] Orchids Collected at Laguna Ocotal Grande, Mexico. Orchid Journ., **3**.

III

LAND AND FRESHWATER MOLLUSKS OF THE SELVA LACANDONA, CHIAPAS, MEXICO

By

Joseph C. Bequaert

To conform with the general plan of the reports on the collections made by Dr. Raymond A. Paynter, Jr., and his associates in Mexico, during the summer of 1954, only the 39 species obtained in the Selva Lacandona have been fully treated below. However, in order to make the paper more generally useful, a list is appended of 49 additional species definitely reported from the State of Chiapas. In this list localities are recorded for 9 species obtained by Dr. Paynter's party outside the Lacandona area. In all, 88 species of inland mollusks are thus known at present from the State of Chiapas, 73 of them terrestrial and 15 aquatic.

As Chiapas has not been visited thus far by a professional malacologist, the 88 species obviously represent only a fraction of the actual molluscan fauna. A comparison with the better known adjoining areas of Mexico (Veracruz) and Guatemala (Petén and Alta Vera Paz), where the ecology and topographical conditions are similar, suggests that the molluscan fauna of Chiapas should comprise some 180 to 200 species. The known 88 species came from several distant localities and were obtained by different collectors during the past 100 years. They may be regarded as a random sample of at least the more common and more conspicuous forms, sufficiently representative to determine the dominant features of the molluscan fauna of the State, as well as of the Selva Lacandona. It should be kept in mind, moreover, that the mollusks of the better explored adjoining territories are as yet far from being completely known.

The 73 terrestrial species will be considered first, as they form the bulk of the fauna and are most interesting from our point of view. At present 26 of them, or about one-third of the total, are known only from Chiapas or extend in a few cases just north of the boundary to Tabasco. Although this figure seems to point to a fairly high degree of endemicity, it is prob-

ably deceptive. Several of these "endemic" species are poorly known, often only from single specimens and not from one or more populations. In fact I am personally acquainted with only eight of these supposedly endemic forms. I suspect that eventually many of them will be recognized as identical with, or within the range of intraspecific variation of more widespread species, recorded under other names from adjoining areas.

The largest group comprises 28 species (slightly over one-third of the total) which generally extend from the western section of Veracruz, through Tabasco and Chiapas, to Guatemala and British Honduras. Of these, 15 are at present recorded from Chiapas (and sometimes Tabasco) to Guatemala, 9 from Veracruz, Tabasco and Chiapas, and 4 from Veracruz to Guatemala; but there can be little doubt that all of them actually occur throughout the whole area. As suggested above, this group will eventually grow by the addition of several of the species now supposedly endemic in Chiapas. It appears to be the dominant and characteristic molluscan assemblage for what may perhaps be called the Chiapas-Guatemalan Subregion of Central America. In all, 54 of the 73 terrestrial species known from Chiapas have not been recorded outside this Subregion.

The remaining species are much more widely distributed. Most of them reach their northern limit in Veracruz, although usually extending southward far beyond Guatemala, in some cases even to Costa Rica and Panama. Four of them are "followers of man," who has spread them far and wide outside their original home, which is now sometimes in doubt.

The very limited freshwater fauna consists of only 15 species. As is often the case for freshwater mollusks in the tropics, they are not particularly characteristic. Seven species are widely distributed throughout Mexico and Central America, or some even beyond; 5 are possibly restricted to the Veracruz-Chiapas-Guatemala area, like the bulk of the terrestrial species; and 3 freshwater clams are at present known only from Chiapas, probably due to insufficient knowledge of the Central American naiad fauna as a whole.

HELICINIDAE

Oligyra flavida (Menke)

Helicina flavida Menke, 1828, Synopsis Meth. Moll., 1st Ed., p. 79 ("Jamaica," [erroneous locality]). Sowerby, 1842, Thesaur. Conchyl., **1**, Pt. 1, p. 9; Pl. 3, figs. 117 and 134; 1866, *Op. cit.*, **3**, Pts. 24-25, p. 287; Pl. 272, figs. 233-236 (Guatemala).

Laguna Ocotal, 950 m.

A common species in southern Mexico (Veracruz, var. *strebeli* Pfeiffer; Tabasco; Chiapas), Guatemala (Petén), and the Republic of Honduras (Copán).

Oligyra oweniana (Pfeiffer)

Helicina oweniana Pfeiffer, 1849 (April), Proc. Zool. Soc. London, (for 1848), p. 123 (Chiapas); 1850, Syst. Conch.-Cab., **1**, Abt. 18, Pt. 1, p. 40; Pl. 7, figs. 35-36 (type).

A common species in Chiapas, Tabasco, Guatemala and Costa Rica. Two forms are represented in the collection from the Selva Lacandona.

1. var. *coccinostoma* Morelet. *Helicina coccinostoma* Morelet, 1849, Test. Noviss. Ins. Cub. Amer. Centr., **1**, (19 Petén). — Laguna Ocotal, 950 m.

2. var. *anozona* von Martens. *Helicina anozona* von Martens, 1876 (April), Proc. Zool. Soc. London, (for 1875), p. 649 (Cobán); 1876, Jahrb. deutsch. Mal. Ges., **3**, p. 261; Pl. 9, fig. 7.— Monte Líbano, 600 m.; El Real, 600 m.

Helicina amoena Pfeiffer

Helicina amoena Pfeiffer, 1849 (April), Proc. Zool. Soc. London, (for 1848), p. 119 (Honduras); 1850, Syst. Conch.-Cab., **1**, Abt. 18, Pt. 1, p. 55; Pl. 5, figs. 13-15 (type).

Laguna Ocotal, 950 m.; El Censo to Laguna Ocotal, 1000 m.; Ocosingo, 850 m.; El Real, 600 m.; Monte Líbano, 600 m.

Known from southern Mexico (Campeche and Chiapas), Guatemala, British Honduras, the Republic of Honduras, Nicaragua, and Panama.

Helicina tenuis Pfeiffer

Helicina tenuis Pfeiffer, 1849 (April), Proc. Zool. Soc. London, (for 1848), p. 124 (Yucatán); 1850, Syst. Conch.-Cab., **1**, Abt. 18, Pt. 1, p. 40; Pl. 7, figs. 33-34 (type).

Helicina chiapensis Pfeiffer, 1856 (December), Mal. Blätt., **3**, p. 237 (Chiapas); 1857 (May), Proc. Zool. Soc. London, (for 1856), p. 380. Sowerby, 1866, Thesaur. Conchyl., **3**, Pts. 24-25, p. 288; Pl. 7, figs. 255-257 (? type from Cuming Collection).

El Real, 600 m.; Monte Líbano, 600 m.

This species is widespread from southern Mexico (Jalisco; Veracruz, Chiapas; Tabasco, Yucatán), to Guatemala (Petén; Alta Vera Paz, and the Pacific slopes of the Cordillera), Nicaragua, Costa Rica, and Panama.

Schasicheila alata (Pfeiffer)

Helicina alata "Menke" Pfeiffer, 1849 (January), Zeitschr. f. Malakoz., **5**, (for June 1848), p. 87 (Mexico); 1850, Syst. Conch.-Cab., **1**, Abt. 18, Pt. 1, p. 43; Pl. 5, figs. 18-20 (type).

Menke's name was given in MS and the original description was written by Pfeiffer, to whom the name should be credited. According to a note on page 96, dated January 10, 1849, the June issue of the Zeitschr. f. Malakoz. for 1848 could not have been published before January 1849.

Monte Líbano, 600 m.

Known from southern Mexico only (Veracruz and Chiapas).

Schasicheila pannucea (Morelet)

Helicina pannucea Morelet, 1849, Test. Noviss. Ins. Cub. Amer. Centr., **1**, p. 21 (San Luis, Petén).

Schasichila pannucea Fischer and Crosse, 1892, Mission Scientif. Mexique, Moll. Terr. Fluv., **2**, Pt. 13, p. 448; Pl. 54, figs. 5 and 5*a* (type from Morelet).

Monte Líbano, 600 m.

Known from much of Mexico (Chiapas; as var. *misantlensis* Fischer and Crosse from Veracruz and Puebla; and as var. *hidalgoana* Dall from Hidalgo, San Luis Potosí and Tamaulipas) and Guatemala (Petén and Alta Vera Paz).

Lucidella lirata (Pfeiffer)

Helicina lirata Pfeiffer, 1847, Zeitschr. f. Malakoz., **4**, p. 150 (Yucatán); 1850, Syst. Conch.-Cab., **1**, Abt. 18, Pt. 1, p. 14; Pl. 4, figs. 40-43 (type).

Laguna Ocotal, 950 m.; Laguna Ocotal to El Censo, 1000 m.

Known from southern Mexico (Veracruz; Chiapas; Tabasco; Yucatán; Quintana Roo), Guatemala, British Honduras, the Republic of Honduras, Nicaragua, Costa Rica, and Panama; and as subsp. *lamellosa* Guppy from Venezuela and Trinidad.

CYCLOPHORIDAE

Neocyclotus dysoni aureus (Bartsch and Morrison)

Aperostoma (*Neocyclotus*) *dysoni aureum* Bartsch and Morrison, 1942, Bull. U. S. Nat. Mus., **181**, p. 209; Pl. 28, figs. 13-15 (Panistlahuaca, Oaxaca).

Neocyclotus dysoni aureum Solem, 1956, Proc. Acad. Nat. Sci. Philadelphia, **108**, p. 53 (Oaxaca: Gamboa. Guatemala: Amatitlán. El Salvador: Lake Coatepeque).

Neocyclotus dysoni Fischer and Crosse, 1888, Mission Scientif. Mexique, Moll. Terr. Fluv., **2**, Pt. 10, p. 164 (in part: specimens from Chiapas only). Not typical *N. dysoni* (Pfeiffer, 1853).

Laguna Ocotal, 950 m.; El Sumidero, Tuxtla-Gutiérrez, 1000 m.

N. dysoni is a common widespread and variable species in southern Mexico (Veracruz; Oaxaca; Tabasco; Chiapas; Campeche; and Yucatán), Guatemala, El Salvador, the Republic of Honduras, Nicaragua, Costa Rica and Panama. The subspecies *aureus* is known from Oaxaca, Chiapas, Tabasco, western Guatemala and El Salvador.

Amphicyclotus palenquensis (Pilsbry)

Aperostoma (*Amphicyclotus*) *palenquense* Pilsbry, 1935, Proc. Acad. Nat. Sci. Philadelphia, **87**, p. 3; Pl. 1, figs. 3 and 3*a-b* (district of Palenque, Chiapas).

Megacyclotus palenquensis Bartsch and Morrison, 1942, Bull. U. S. Nat. Mus., **181**, p. 183; Pl. 24, figs. 16-18 (type).

Amphicyclotus (*Amphicyclotus*) *palenquense* Solem, 1956, Proc. Acad. Nat. Sci. Philadelphia, **108**, p. 44 (Veracruz: Motzorongo).

Laguna Ocotal, 950 m.; Monte Líbano, 600 m.; El Censo to

Laguna Ocotal, 700-1000 m.; Monte Líbano to El Censo, 600-700 m.

The 30 specimens from the Lacandona area agree well in shape and in sculpture with the descriptions and figures of Pilsbry and of Bartsch and Morrison. When well preserved, the sculpture consists of microscopic, spiral, slightly wavy, densely crowded lines and coarser diagonal, curved threads, spirally ascending forward and crossing the irregular, vertical growth lines. The retractive threads are often irregular or interrupted by coarse malleations and are usually best marked at the periphery, below which they are sometimes nearly horizontal.

The species was known thus far from only three specimens. The type measured 20.7 mm. in height, 34 mm. in greater diameter and 25.9 mm. in lesser diameter. The corresponding figures for the paratype were 21.7 mm., 34.3 mm. and 26.1 mm. As will be seen from the subjoined table, some of the 22 fully adult shells of the Selva Lacandona approach these measurements closely; a few are slightly smaller (down to 29.8 mm. in greater diameter and 18 mm. high), and several are decidedly larger (up to 41.5 mm. in greater diameter and 24.7 mm. high). The larger specimens seem to bridge the gap between *A. palenquensis* and *A. ponderosus* (Pfeiffer), so far as size is concerned. To judge from the specimens of *A. ponderosus* at the M.C.Z., that species has, however, a decidedly higher spire and a less flattened, more convex body-whorl, as well as a deeper and somewhat narrower umbilicus, than *A. palenquensis*. The sculpture seems to be about the same in both species.

The specimen of *A. ponderosus* figured by Bartsch and Morrison was of about the size of our largest *A. palenquensis*. Other known specimens are, however, much larger (up to 48.5 mm. in greater diameter and 29 mm. high in a series of 4 specimens from northern Guatemala at M.C.Z.). It is therefore possible that *A. ponderosus*, definitely recorded only from Guatemala (Alta Vera Paz) and British Honduras, actually grows larger than *A. palenquensis*. The latter is known only from northeastern Chiapas, the Selva Lacandona being some 70 km. south of Palenque.

In general shape, measurements, depressed spire and widely open umbilicus *A. palenquensis* resembles *Amphicyclotus megaplanus* Morrison (1955, Proc. Washington Acad. Sci., **45**, p. 160,

figs. 29-31), from El Ocote, some 35 km. south of Ocozocoautla, Chiapas and some 180 km. west of the Selva Lacandona. However, the sculpture of the later whorls of *megaplanus* is described as "consisting of fine irregular axial vermiculate ribbing," being similar to that of *Amphicyclotus texturatus* (Sowerby). Solem suggests that *megaplanus* may be only a local race of *texturatus*.

Measurements of Adult *Amphicyclotus palenquensis* (in mm.)

Width			Aperture				
Height	Greater	Lesser	Height	Width	Whorls		
20.3	38.4	29	19.2	17.7	5½	Laguna Ocotal	
20	36.2	27.4	17	15.5	5½	"	"
20	35	27.3	16.8	15.5	5⅓	"	"
20	34.5	27.5	18	14.4	5⅓	"	"
23.7	38	30	18	16.5	5½	Monte Líbano	
20.7	37.3	29.3	19.8	16.8	5½	"	"
21.5	37	28	18.3	17	5½	"	"
21.5	36	28	18	17	5½	"	"
20.8	35	27	18	16	5⅓	"	"
21	35	27	16.6	15.2	5⅓	"	"
21	34.5	27.2	16	15.2	5⅓	"	"
20	33.6	27.5	16.5	15.4	5¼	"	"
20.8	32.5	25	15.8	15	5¼	"	"
18	31.5	26.4	14	13.5	5¼	"	"
18.3	31	23.5	15.3	13.7	5¼	"	"
19	29.8	24	14.3	13.7	5⅕	"	"
24.7	38.7	30.4	19.8	18.8	5½	El Censo to L. Ocotal	
21.2	37.6	27	18.4	16.2	5½	"	"
22.8	37.3	27	18.6	16.7	5½	"	"
20.5	38	30	18	15.7	5½	Monte Líbano to El Censo	
20	36.5	27	17.2	15.2	5⅓	"	"
22	36.4	28.5	17.3	16	5⅓	"	"

PILIDAE (AMPULLARIIDAE)

Pomacea flagellata ghiesbrechtii (Reeve)

Ampullaria ghiesbrechtii Reeve, 1856 (December), Conch. Icon., **10**, *Ampullaria*, Pl. 26, fig. 123 (Chiapas).

Ampullaria ghiesbreghti Binney, 1865, Land Fresh-Water Shells North America, **3**, (Smithson. Misc. Coll. No. **143**), p. 7 (emendation of *ghiesbrechtii*).

Ampullaria livescens Reeve, 1856 (August), Conch. Icon., 10, *Ampullaria*, Pl. 5, fig. 21 (no locality).

Ampullaria miltocheilus Reeve, 1856 (December), Conch. Icon., 10, *Ampullaria*, Pl. 25, figs. 102*a-b* (Chiapas).

Pomus giganteus Tristram, 1863, Proc. Zool. Soc. London, p. 414 (Lake of Petén, Guatemala).

Ampullaria flagellata var. *gigantea* von Martens, 1899, Biologia Centr.-Amer., Terr. Fluv. Moll., p. 412; Pl. 23, fig. 6 (cotype received from Tristram).

Ampullaria malleata var. *chiapasensis* Fischer and Crosse, 1890, Mission Scientif. Mexique, Moll. Terr. Fluv., 2, Pt. 11, p. 235; Pl. 48, fig. 5 (Las Playas, Chiapas; [immature shell duplicated by some specimens from Laguna Ocotal]).

Laguna Ocotal, 950 m., many young shells. The largest measures 53 mm. in length, 50 mm. in greatest width, with the aperture 40 mm. by 24 mm.

Pomacea flagellata (Say) is the common ampullariid snail in Mexico and Central America, from Veracruz southward, as far as Panama and northern Colombia. It is extremely variable in shape and size (when adult), even in the same population. Some 30 names have been proposed for these variations and, as some of these have been proposed either for unusual or freak specimens or for immature or juvenile snails, it is extremely difficult to dispose of them as synonyms of the few races or geographical forms that may be usefully recognized.

One of the best characterized of these races, seemingly restricted to Tabasco, Chiapas and northern Guatemala, is nearly globular in shape, usually about as high as its greatest width, sometimes slightly higher or slightly lower. Under optimum conditions it may reach greater dimensions than any of the other races of the species. "Giant" specimens are particularly common in Lake Petén, whence Tristram described his *P. giganteus*. The original measurements given by Tristram were: height, 95 mm.; greatest diameter, 90 mm.; lesser diameter, 85 mm.; aperture, 66 by 39 mm. The cotype figured by von Martens is 92 mm. high, with the aperture 69.5 mm. long. The largest specimen I have seen from Lake Petén is 102.5 mm. high, 88 mm. in greatest width, with the aperture 74.3 by 42 mm., of about 6 whorls. The largest of several collected by Mr. F. G. Thompson 4 miles south of Villahermosa, Tabasco, is 83 mm. high and 75 mm. wide.

There can be little doubt that the type of Reeve's *A. ghiesbrechtii* was a slightly smaller specimen of *P. giganteus* with unusually bright vermilion margins of the aperture. A brightly colored aperture occurs sporadically in several species of *Pomacea*, but is never a reliable specific character. The color may be more or less pronounced, and, moreover, is often more orange, as in Fischer and Crosse's figure of *A. ghiesbrechtii* from the Usamacinta River in Tabasco (Miss. Scientif. Mexique, Moll. Terr. Fluv., **2**, Pl. 48, fig. 8), where it is present only over the outer margin of the mouth. Reeve's figure of the type of *ghiesbrechtii* is 85 mm. high, 73 mm. in greatest width, with the aperture 59 mm. by 36.5 mm.

A. miltocheilus Reeve appears to be no more than a small specimen *of A. ghiesbrechtii;* it was collected by the same person in Chiapas also, and both may have come from the same population. The figure is 48 mm. high, 43 mm. in greatest width, with the aperture 36.5 mm. by 21.5 mm. The aperture has the same bright vermilion color as the type of *ghiesbrechtii.*

A. livescens Reeve agrees well with some young specimens of *A. ghiesbrechtii* found in Lake Petén with the giant specimens. Although the name was published some months before *ghiesbrechtii,* I prefer to use the latter, because it was based on a fully adult shell from a precise locality and dates from the same year.

POMATIASIDAE

Chondropoma rubicundum (Morelet)

Cyclostoma rubicundum Morelet, 1849, Test. Noviss. Ins. Cub. Amer. Centr., **1**, p. 22 (Petén and Vera Paz, Guatemala).

Chondropoma rubicundum Fischer and Crosse, 1890, Mission Scientif. Mexique, Moll. Terr. Fluv., **2**, Pt. 11, p. 205; Pl. 41, figs. 5*f-h* (cotype from Vera Paz).

Laguna Ocotal, 950 m.

Known from Tabasco, Chiapas and Guatemala (Petén and Alta Vera Paz).

BULIMIDAE (HYDROBIIDAE)

Amnicola guatemalensis Fischer and Crosse

Paludina hyalina Morelet, 1851, Test. Noviss. Ins. Cub. Amer. Centr., **2**, p. 21 (Lake Amatitlán, Guatemala). Not of Anton, 1839.

Amnicola guatemalensis Fischer and Crosse, 1891, Mission Scientif. Mexique, Moll. Terr. Fluv., **2**, Pt. 12, p. 264; Pl. 50, figs. 5 and 5*a-b* (cotypes; new name for *hyalina* Morelet).

Laguna Ocotal, 950 m.; many dead specimens in a silt deposit on the shore.

The species, known thus far from several localities in Guatemala (Amatitlán; Petén; etc.), is now reported for the first time from Chiapas. Guatemalan specimens were compared.

Cochliopa infundibulum von Martens

Cochliopa (?) *infundibulum* von Martens, 1899, Biologia Centr.-Amer., Terr. Fluv. Moll., p. 429; Pl. 23, fig. 3 (Guatemala, without precise locality; surmises it may be from Lake Petén).

Laguna Ocotal, 950 m. Many dead specimens in a silt deposit on the shore.

Previously known only from Lake Petén and Laguna de Ecki-bix, in northern Guatemala (Goodrich and Van der Schalie, 1937, Mus. Zool. Univ. Michigan, Misc. Publ. No. **34**, p. 37); now reported for the first time from Chiapas. Guatemalan specimens were compared.

THIARIDAE (MELANIIDAE)

Pachychilus indiorum (Morelet)

Melania indiorum Morelet, 1849, Test. Noviss. Ins. Cub. Amer. Centr., **1**, p. 25 (Palenque, Chiapas).

Melania indorum Petit, 1853, Jour. de Conchyliologie, **4**, p. 162; Pl. 5, fig. 7 (cotype received from Morelet).

Melania laevissima var. *costato-plicata* Brot, 1875, Syst. Conch.-Cab., **1**, Abt. 24, p. 35; Pl. 5, fig. 5 (Palenque, Chiapas).

Pachychilus laevissimus var. *varicosa* Fischer and Crosse, 1892, Mission Scientif. Mexique, Moll. Terr. Fluv., **2**, Pt. 13, p. 329; Pl. 53, fig. 6 (Palenque, Chiapas).

Monte Líbano, 600 m.; El Censo, 700 m.; Ocosingo, 850 m.; El Real, 600 m. Also many dead shells, found with bones in a rock

shelter near Laguna Ocotal, and others from gopher diggings nearby. No specimens were found alive either in the Laguna or in the streams in the vicinity. The specimens were compared with topotypes collected by Dr. L. Mazotti.

A common freshwater snail in the smaller streams and rivers of Chiapas, Tabasco, Oaxaca, and of eastern and northern Guatemala (Petén, Alta Vera Paz).

PLANORBIDAE

Helisoma caribaeum (d'Orbigny)

Planorbis caribaeus d'Orbigny, 1841, *in* de la Sagra, Hist. Fis. Pol. Cuba, Moll., Pt. 1, p. 103; Pl. 13, figs. 17-19 (Havana, Cuba; and Veracruz, Mexico).

Planorbis ancylostomus var. *chiapasensis* Fischer and Crosse, 1880, Mission Scientif. Mexique, Moll. Terr. Fluv., **2**, Pt. 8, p. 63; Pl. 34, figs. 5 and 5*a-b* (Chiapas).

Laguna Ocotal, 950 m.; Río Amarillo at the Sumidero near Las Casas (Mrs. L. Whitaker).

A common species throughout Central America, from Veracruz to Panama, and in the Antilles, from Cuba to Barbados.

Tropicorbis obstructus (Morelet)

Planorbis obstructus Morelet, 1849, Test. Noviss. Ins. Cub. Amer. Centr., **1**, p. 17 (Island of Carmen, Campeche).

Planorbula obstructa Fischer and Crosse, 1880, Mission Scientif. Mexique, Moll. Terr. Fluv., **2**, p. 78; Pl. 33, figs. 8 and 8*a-d* (type from Morelet); Pl. 34, figs. 7 and 7*a-c* (var. *berendti* Tryon from Orizaba or Veracruz).

Laguna Ocotal to El Censo; a few dead, but fairly fresh specimens.

Definitely known from southern Mexico (Veracruz; Campeche; Oaxaca; Yucatán; Chiapas), Guatemala and British Honduras: The species possibly extends to southern Texas.

Taphius subpronus (von Martens)

Planorbis (*Taphius*) *subpronus* von Martens, 1899, Biologia Centr.-Amer., Terr. Fluv. Moll., p. 396; Pl. 21, 4 figs. 15 (Amatitán, State of Tabasco, Mexico).

? *Taphius subpronus* F. C. Baker, 1945, Molluscan Family Planorbidae, p. 79; Pl. 131, figs. 36-40 (Turrialba, Costa Rica; U.S.N.M. No. 162827).

Laguna Ocotal, 950 m., many dead specimens in a silt deposit on the shore. I have also seen some fresh specimens of this remarkable snail from Lake Coatepeque, El Salvador (N. C. Fassett Coll. — Received through Dr. H. W. Levi).

Von Martens commented upon the close similarity of *subpronus* and *Taphius pronus* von Martens of Lake Valencia, Venezuela. It is, indeed, impossible to point out a reliable difference in the general shape, the method of coiling, the degree of deflection of the aperture, the shape of the aperture and the relative width and depth of the umbilicus, particularly as *T. pronus* varies greatly in all these characters. There remains only the fine spiral striation of the shell, present in fresh specimens of *T. pronus*. There is no trace of this, neither on the weathered specimens from Laguna Ocotal (where they might be worn), nor on the very fresh specimens from Lake Coatepeque. The largest specimen from Laguna Ocotal is 8 mm. in greatest width and 2.8 mm. thick. The largest of the 5 specimens from Lake Coatepeque is 4.5 mm. in greatest width and 2 mm. thick, approximating von Martens' original measurements of 5 mm. and 2 mm.

I am not fully satisfied that F. C. Baker's figures, cited above, actually represent true *T. subpronus*.

ANCYLIDAE

Ferrisia excentrica (Morelet)

Ancylus excentricus Morelet, 1851, Test. Noviss. Ins. Cub. Amer. Centr., **2**, p. 17 (Lake Itzá [= Petén], Guatemala).

Ancylus (*Ancylastrum*) *excentricus* Fischer and Crosse, 1880, Mission Scientif. Mexique, Moll. Terr. Fluv., **2**, Pt. 7, p. 37; Pl. 30, figs. 16-16*a* (type from Morelet).

Laevapex excentricus B. Walker, 1924, The Ancylidae of South Africa, p. 10.

Ferrisia (*Laevapex*) *excentrica* Goodrich and Van der Schalie, 1937, Mus. Zool. Univ. Michigan, Misc. Publ. No. **34**, p. 34.

Laguna Ocotal, 950 m., several living specimens in floating vegetation.

Known from southern Texas to Costa Rica.

SUBULINIDAE

Lamellaxis exiguus (von Martens)

Leptinaria exigua von Martens, 1898, Biologia Centr.-Amer., Terr. Fluv. Moll., p. 318; Pl. 18, fig. 10 (Teapa in Tabasco).

Laguna Ocotal, 950 m.; Ocosingo, 1000 m.

As von Martens suspected, the original specimens, 5 mm. long, were immature. The lot from Laguna Ocotal comprises three immature shells agreeing with the original description and figure, and one adult, 11.2 mm. long, 5.5 mm. in greatest width, the aperture 5 mm. by 3 mm., of 6½ whorls; the body-whorl is 7 mm. long in front view. The spaced, costulate sculpture of the earlier (post-nepionic) whorls changes gradually to close, finer vertical striae on the later whorls; the striation is replaced by exceedingly fine vertical engraved lines below the periphery of the body-whorl; the first 2 (nepionic) whorls are smooth. In the full-grown shell the columella is shaped about as originally drawn for the young, but the median fold is slightly more pronounced. The outer columellar area is broad and its margin is spread over the wide and deep umbilicus.

The species is known only from Tabasco and Chiapas.

Synopeas beckianum (Pfeiffer)

Bulimus beckianus Pfeiffer, 1846, Symbolae Hist. Helic., **3**, p. 82 (Opara I. ?); 1848, Monogr. Helic. Viv., **2**, p. 164; 1854, Syst. Conch.-Cab., **1**, Abt. 13, Pt. 1, p. 125; Pl. 36, figs. 29-31 (type).

Opeas micra von Martens, 1898, Biologia Centr.-Amer., Terr. Fluv. Moll., p. 294; Pl. 17, figs. 10-11. Not of d'Orbigny, 1835.

Opeas beckianum Pilsbry, 1906, Man. Conch., (2), **18**, p. 189; Pl. 27, figs. 42-46 and 54-55.

Ocosingo, 850 m.; Laguna Ocotal, 950 m.; Monte Líbano to El Censo, 600-700 m.

Widely distributed throughout tropical America, from Veracruz to São Paulo, Brazil, and Peru, as well as throughout the Antilles. It has possibly been spread by man. Pfeiffer's original locality appears to have been erroneous.

The species is evidently not a true *Opeas* and I have followed H. B. Baker (1927, Occ. Papers Mus. Zool., Univ. Michigan, No. **182**, p. 7) in placing it in *Synopeas* Jousseaume (1899). This generic name appears to be antedated, however, by *Synopeas* Foerster (1856) and a substitute may have to be proposed.

OLEACINIDAE

Spiraxis scalariopsis (Morelet)

Bulimus scalariopsis Morelet, 1851, Test. Noviss. Ins. Cub. Amer. Centr., **2.** p. 11 (Petén, Guatemala).

Spiraxis scalariopsis Fischer and Crosse, 1877, Mission Scientif. Mexique, Moll. Terr. Fluv., **1.** Pt. 6, p. 609; Pl. 25, figs. 1 and 1*a-b* (type from Morelet's collection).

Monte Líbano to El Censo, 600-700 m.

Known only from Chiapas and Guatemala (Petén).

Spiraxis similaris (Strebel)

Volutaxis similaris Strebel, 1882, Beitr. Mexikan. Land- Süsswasser-Conch., **5.** p. 122; Pl. 7, fig. 11; Pl. 17, fig. 18 (Veracruz: Pacho near Jalapa).

Laguna Ocotal to El Censo, 600-700 m., on *Philodendron.*

Known only from Veracruz and Chiapas.

Streptostyla chiapensis Pilsbry

Spiraxis parvula Pfeiffer, 1856 (December), Malakoz. Blätt., **3.** p. 234 (Chiapas); 1857 (May), Proc. Zool. Soc. London, (for 1856), p. 379 (Chiapas). Not *Achatina parvula* Chitty, 1853, now placed rather doubtfully in *Spiraxis.*

Streptostyla limnaeiformis var. *parvula* von Martens, 1892, Biologia Centr.-Amer., Terr. Fluv. Moll., p. 100; Pl. 5, fig. 24 (specimen from Chiapas, in Pfeiffer's Coll., but probably not the type).

Streptostyla limneiformis chiapensis Pilsbry, 1909, Man. Conch., (2), **20.** p, 111 (new name for *Spiraxis parvula* Pfeiffer, 1856).

Laguna Ocotal, 950 m.

The specimen collected at Laguna Ocotal, 6.5 mm. long, shows the deep lines of growth mentioned by von Martens. I regard *chiapensis* as specifically distinct from *S. limneiformis* (Shuttleworth, 1852). *Streptostyla oblonga* (Pfeiffer, 1856) differs from *chiapensis* in the smooth surface of the shell.

Known only from Chiapas.

Euglandina monilifera (Pfeiffer)

Glandina monilifera Pfeiffer, 1845 (October), Proc. Zool. Soc. London, p. 75 (Cobán, "Veracruz" [error for Vera Paz, Guatemala]).

Achatina monilifera Reeve, 1849, Conch. Icon., **5.** *Achatina*, Pl. **14, fig. 50** (Cobán; from Dennison Coll.).

Monte Líbano, 600 m.; Monte Líbano to El Censo, 600-700 m.

Known from Veracruz, Guerrero, Chiapas, Guatemala (Petén; Alta Vera Paz), and Costa Rica.

Euglandina ghiesbreghti (Pfeiffer)

Oleacina ghiesbreghti Pfeiffer, 1856 (December), Malakoz. Blätt., **3**, p. 235 (Chiapas).

Achatina (*Oleacina*) *ghiesbreghti* Pfeiffer, 1857 (May), Proc. Zool. Soc. London, (for 1856), p. 379 (Chiapas).

Glandina ghiesbreghti Strebel, 1875, Beitr. Mexikan. Land- Süsswasser-Conch., **2**, p. 39; Pl. 10, figs. 31 and 31*a-d* (possibly 2 paratypes?).

Laguna Ocotal, 950 m.; El Censo to Laguna Ocotal, 700-1000 m.

This species was known thus far from Chiapas and Tabasco; but I have seen a specimen from Yepocapa, Dept. Chimaltenango, Guatemala (H.T. Dalmat Coll.), some 125 km. east of Chiapas.

SAGDIDAE

Thysanophora impura (Pfeiffer)

Helix impura Pfeiffer, 1866, Malakoz. Blätt., **13**, p. 79 (Mirador, Veracruz).

Thysanophora impura Strebel, 1880, Beitr. Mexikan. Land- Süsswasser-Conch., **4**, p. 30; Pl. 4, 3 figs. 2 (Mirador, topotype; not Pfeiffer's holotype, which was never figured). Pilsbry, 1926, Proc. Acad. Nat. Sci. Philadelphia, **78**, p. 121, figs. 36A-B (Veracruz: Antigua; Pacho; Veracruz. Yucatán: Tekanta; Tunkas; Mérida). Thiele, 1931, Handb. Syst. Weichtierk., **2**, p. 582, fig. 664.

Ocosingo, 850 m.

Known definitely at present from southeastern Mexico (Veracruz, Chiapas and Yucatán). Published records from elsewhere are open to question because the species has often been confused with *T. conspurcatella* (Morelet, 1851).

Thysanophora pilsbryi H. B. Baker

Thysanophora pilsbryi H. B. Baker, 1922, Occ. Papers Mus. Zool., Univ. Michigan, No. **106**, p. 54; Pl. 17, figs. 11-14 (Veracruz: La Laja near the Hacienda de Cuatotolapan).

Laguna Ocotal, 950 m.

Known only from Veracruz and Chiapas.

Thysanophora fuscula (C. B. Adams)

Helix fuscula C. B. Adams, 1849, Contributions to Conchology, No. **2**, p. 35 (Jamaica).

Thysanophora fuscula Pilsbry, 1920, The Nautilus, **33**, Pt. 3, p. 94, 2 figs. 1 (on p. 93, after a cotype; synonymizes with it *T. fischeri* Pilsbry, 1904).

Thysanophora fischeri Pilsbry, 1904 (January 30), Proc. Acad. Nat. Sci. Philadelphia, (for 1903), p. 763; Pl. 49, figs. 6-6*a* (Tamaulipas: 4 miles west of Victoria).

Laguna Ocotal, 950 m.; Monte Líbano, 600 m.

Known from Tamaulipas, Veracruz, Chiapas and Jamaica.

ZONITIDAE

Habroconus trochulinus (Morelet)

Helix trochulinus Morelet, 1851, Test. Noviss. Ins. Cub. Amer. Centr., **2**, p. 10 ("H. non frequens in sylvas Petenenses, circa Sancti-Ludovici pagum;" [=San Luis, Petén, probably the locality of that name in about 16°15'N., 89°25'W.]).

Guppya trochulina von Martens, 1892, Biologia Centr.-Amer., Terr. Fluv. Moll., p. 120; Pl. 6, figs. 17 and 17*a-d* (Morelet's type, "the only specimen which still exists in his collection").

Habroconus trochulinus H. B. Baker, 1930, Occ. Papers Mus. Zool., Univ. Michigan, No. **220**, p. 22; Pl. 7, figs. 10-11 (Veracruz: Penuela to Sumidero, 2625-3400 ft.; Necaxa, 2215-4925 ft.; "common at lower altitudes on leaves of shrubs and trees, quite arboreal").

Laguna Ocotal to El Censo, 700-1000 m., on *Philodendron;* El Real, 600 m.

The specimens from Chiapas agree with H. B. Baker's interpretation of Morelet's *H. trochulina,* which fortunately is in accord with Morelet's type as figured by von Martens. That figure shows the body-whorl even more angulate at the periphery than figured by Baker.

Von Martens concluded that *Helix selenkai* Pfeiffer (1866) could not be separated from *H. trochulinus,* whereas H. B. Baker regards them as distinct (although recognizing that they may only represent two ecological forms). The material before me is too small to decide the matter. A lot of 27 specimens, from the T. Bland Collection, collected at Mirador, Veracruz, by Berendt, who distributed them as *H. selenkai,* appear to be all

H. trochulinus; but the carina at the periphery varies from very strongly marked (more so than drawn by von Martens) to barely indicated, with all transitional stages between these two extremes.

If restricted as H. B. Baker does, *H. trochulinus* is known definitely only from Veracruz, Chiapas and Petén.

Omphalina bilineata (Pfeiffer)

Helix bilineata Pfeiffer, 1846 (February), Proc. Zool. Soc. London, (for 1845), p. 128 ("locality unknown"); 1852, Syst. Conch.-Cab., **1.** Abt. 12, Pt. 2, p. 96; Pl. 83, figs. 23-25 (type; no locality).

Hyalina (*Zonyalina*) *bilineata* Pfeiffer, 1865, Malakoz. Blätt., **12.** p. 16 (Veracruz).

Omphalina bilineata von Martens, 1892, Biologia Centr.-Amer., Terr. Fluv. Moll., p. 109; Pl. 6, fig. 6 (several localities for the typical form and the varieties, all in the State Veracruz).

Mesomphix (*Zonyalina*) *bilineatus* H. B. Baker, 1930, Occ. Papers Mus. Zool., Univ. Michigan, No. **220.** p. 28; Pl. 9, figs. 2-4 (anatomy; 2 localities in Veracruz).

Omphalina (*Zonyalina*) *bilineata* Thiele, 1931, Handb. Syst. Weichtierk., **2.** p. 590.

Laguna Ocotal, 950 m.

Known thus far only from Veracruz and now recorded also from Chiapas.

BULIMULIDAE

Bulimulus unicolor (Sowerby)

Bulinus unicolor Sowerby, 1833 (July 12), Conchol. Illustr., Pt. 34, Pl. of *Bulinus*, fig. 43 (with name in accompanying printed list; Panama); 1833 (September 26), Proc. Zool. Soc. London, p. 73 (Island of Perico, Gulf of Panama).

Bulimulus unicolor Pilsbry, 1897, Man. Conch., (2), **11.** p. 53; Pl. 10, fig. 73.

Ocosingo, 1000 m.

Widespread in Central America, from Tabasco and Chiapas to Panama.

Drymaeus moricandi (Pfeiffer)

Bulimus moricandi Pfeiffer, 1847 (January), Proc. Zool. Soc. London, (for 1846), p. 113 (Cobán, [Guatemala]). Reeve, 1848, Conch. Icon., **5.**

Bulimus, Pl. 45, fig. 283 ("Central America;" ? type from Cuming Coll.).

Bulimulus (*Drymaeus*) *moricandi* Fischer and Crosse, 1875, Mission Scientif. Mexique, Moll. Terr. Fluv., 1, Pt. 5, p. 497; Pl. 24, figs. 9-9*a* (Guatemala: Cobán; Vera Paz; Dueñas; with var. *hyalino-albida*, p. 498, from Chiapas).

Drymaeus moricandi Pilsbry, 1899, Man. Conch., (2), **12**, p. 78; Pl. 4, figs. 62 (after Reeve) and 63-64 (after Fischer and Crosse).

El Censo to Laguna Ocotal, 700-1000 m.

The five mostly adult specimens collected belong to the var. *hyalino-albida* Fischer and Crosse (1875), being clear whitish, although very fresh. Apart from color, they agree not only with the published figures of Reeve and of Fischer and Crosse, but also with specimens from the Bland Collection (now at M.C.Z.), labeled Guatemala.

There has been some doubt about the specific distinctness of *D. moricandi* and *Drymaeus sulphureus* (Pfeiffer, 1857), probably because of the similarity in color (both species having a pure white and a citron-yellow phase) and the fact that they may occur together in Guatemala. In the series I have compared, full-grown *moricandi* differs consistently in being broader at the body-whorl, with a wider spire, in the longer aperture (which reaches at least half of the total length of the shell), in a relatively wider columellar area, and in a more open and perforate umbilicus. Immature shells are, however, difficult to separate. The largest shell seen from Chiapas is 29 mm. long, 14 mm. in greatest width, the aperture 17 mm. by 9.5 mm.

D. moricandi is only known with certainty from Chiapas and the adjoining northeastern section of Guatemala. *D. sulphureus* is more widely distributed from Veracruz to Costa Rica.

Simpulopsis simula (Morelet)

Bulimus simulus Morelet, 1851, Test. Noviss. Ins. Cub. Amer. Centr., **2**, p. 11 (Petén, Guatemala).

Simpulopsis simula Fischer and Crosse, 1877, Mission Scientif. Mexique, Moll. Terr. Fluv., 1, Pt. 6, p. 578; Pl. 24, figs. 13-13*a* (type from Morelet).

Laguna Ocotal to El Censo, 700-1000 m., on *Philodendron*.

Known only from northern Guatemala (Petén) and Chiapas. This appears to be the second record for the species, which is

probably overlooked because of its extreme fragility and its habitat on leaves of epiphytic plants.

Orthalicus princeps (Broderip)

Bulinus princeps Broderip, 1833 (May 3), Conchol. Illustr., Pt. 27, Pl. of *Bulinus*, 2 figs. 18 (with name in printed list; "Conchagua, Central America" [El Salvador]).

Oxystyla princeps Pilsbry, 1899, Man. Conch., (2), **12**, p. 113; Pl. 16, figs. 1-9; Pl. 17, figs. 10-12.

Monte Líbano, 600 m.; Monte Líbano to El Censo, 600-700 m.; San Lorenzo, midway between Ocosingo and El Real.

Known from southern Mexico (Veracruz and Sinaloa) to Panama.

UROCOPTIDAE

Eucalodium mexicanum (Pfeiffer)

Cylindrella mexicana "Cuming" Pfeiffer, 1860 (February-June), Proc. Zool. Soc. London, p. 139 ("Mexico").

Eucalodium (*Eucalodium*) *mexicanum* Pilsbry, 1902, Man. Conch., (2), **15**, p. 6; Pl. 1, figs. 2-3; Pl. 7, figs. 8-10.

Monte Líbano, 600 m.

Known only from Chiapas and Tabasco.

Coelocentrum tomacella (Morelet)

Cylindrella tomacella Morelet, 1849, Test. Noviss. Ins. Cub. Amer. Centr., **1**, p. 10 (Tabasco).

Coelocentrum tomacella Fischer and Crosse, 1873, Mission Scientif. Mexique, Moll. Terr. Fluv., **1**, Pt. 3, p. 342; Pl. 15, fig. 11 (type from Morelet; Tabasco and Palenque in Chiapas).

Laguna Ocotal, 950 m.; Monte Líbano to El Censo, 600-700 m.

Known from Tabasco, Chiapas and eastern Guatemala (Cobán).

Microceramus concisus (Morelet)

Cylindrella concisa Morelet, 1849, Test. Noviss. Ins. Cub. Amer. Centr., **1**, p. 12 (Yucatán).

Macroceramus concisus Fischer and Crosse, 1873, Mission Scientif. Mexique, Moll. Terr. Fluv., **1**, Pt. 4, p. 421; Pl. 18, figs. 1 and 1*a-b* (type from Morelet).

Microceramus concisus Pilsbry, 1903, Man. Conch., (2), **16**, p. 155; Pl. 25, figs. 7-12.

Laguna Ocotal, 950 m.; Ocosingo, 1000 m.

Known from Chiapas, Yucatán, Guatemala, Utilla I. off the coast of Honduras, and Costa Rica. Most probably *M. concisus* is not specifically distinct from *M. gossei* (Pfeiffer, 1846), from Jamaica and (probably) Cuba, the Bahamas, and Hispaniola.

CEPOLIDAE

Leptarionta trigonostoma (Pfeiffer)

Helix trigonostoma Pfeiffer, 1844 (October), in Philippi, Abbild. Beschr. Conchyl., **1**, Pt. 7, p. 154 (or p. 24); Pl. 5 [mislabeled 4] of *Helix*, 2 figs. 8 ("provincia Honduras Americae centralis"); 1845 (August), Proc. Zool. Soc. London, p. 41 ("Veracruz, Province of Honduras, Central America;" [a fictitious, truly Cumingian locality]).

Helix (*Geotrochus*) *trigonostoma* Fischer and Crosse, 1872, Mission Scientif. Mexique, Moll. Terr. Fluv., **1**, Pt. 2, p. 291; Pl. 11, figs. 6 and 6*a-d* (Guatemala: Petén; Vera Paz; San Augustin; Sierra del Mico, near Izabal).

Helix (*Oxychona*) *trigonostoma* Pilsbry, 1889, Man. Conch., (2) **5**, p. 132; Pl. 14, figs. 1-4; Pl. 18, figs. 1-2. von Martens, 1892, Biologia Centr.-Amer., Terr. Fluv. Moll., p. 154; Pl. 9, figs. 1, 1*a*, 9, 9*a*, 11 and 12, (additional localities in Guatemala: Senahu, N. side of Polochic Valley, above Panzas; Vera Paz; Cobán; near Guatemala City, 5000 ft.; San Juan Riv.; Cerro Zunil, Pacific Slope near Quezaltenango; El Reposo between Retalhuleu and the Pacific; slope of Cordillera, at 2500-4500 ft., at Hacienda San Francisco, Miramar and Helvetia, Buenavista).

Oxychona trigonostoma Pilsbry, 1894, Man. Conch., (2), **9**, p. 190.

Leptarionta trigonostoma Pilsbry, 1897, The Nautilus, **11**, No. 8, p. 88.

Laguna Ocotal, 950 m.; El Censo to Laguna Ocotal, 700-1000 m.; Monte Líbano to El Censo, 600-700 m.

The species is now for the first time recorded from reliable Mexican localities, in Chiapas. The supposed occurrence in "Veracruz" has never been confirmed and was evidently one more of the many erroneous localities in the Cuming Collection. The record from "Honduras" is likewise based on an error from the same source. *L. trigonostoma* is restricted to Guatemala and Chiapas, so far as known at present. Dr. H. T. Dalmat collected specimens in Guatemala at Yepocapa, Dept. Chimaltenango, and at the Finca Montequina, Atitlán, Dept. Solola.

The species varies somewhat, not only in the banding, but also in the shape and slope of the spire. I agree with Pilsbry (1899) that it is scarcely useful to distinguish these variants by names, except as collector's items.

Averellia coactiliata (Deshayes)

Helix coactiliata "Férussac" Deshayes, 1839, *in* Férussac, Hist. Nat. Gén. Part. Moll. Terr. Fluv., **1**, p. 19; Pl. 75, figs. 1-5 (Real-Llejos, Nicaragua; and "environs de Touspan, au Pérou" [error for Tuxpan, Veracruz, Mexico]).

Helix (*Patula*) *coactiliata* Fischer and Crosse, 1872, Mission Scientif. Mexique, Moll. Terr. Fluv., **1**, Pt. 2, p. 234.

Helix (*Patula, Discus, Trichodiscus*) *coactiliata* Pilsbry, 1887, Man. Conch., (2), **3**, p. 49; Pl. 5, fig. 2.

Helix (*Trichodiscina*) *coactiliata* von Martens, 1892, Biologia Centr.-Amer., Terr. Fluv. Moll., p. 133.

Epiphragmophora (*Trichodiscina*) *coactiliata* Pilsbry, 1894, Man. Conch., (2), **9**, p. 199.

Averellia (*Trichodiscina*) *coactiliata* Thiele, 1931, Handb. Syst. Weichtierk., **2**, p. 698.

As neither the original description nor the figures were written or published by Férussac (who died in 1836), the name should be credited to Deshayes.

Laguna Ocotal, 950 m.; El Real, 600 m.

A widely distributed snail, perhaps transported sometimes by man. It is known from Tamaulipas, San Luis Potosí, Michoacán, Veracruz, Tabasco, Chiapas, Yucatán, Guatemala, British Honduras, Nicaragua, Panama, Venezuela and Trinidad.

I am unable to separate *Helix cordovana* Pfeiffer (1857) from *A. coactiliata*.

Additional Species Recorded From Chiapas

The following list of species known from Chiapas, but not mentioned in the preceding pages, is based on published records, as well as on specimens collected by Dr. R. A. Paynter, Jr. and his associates, and more recently (1956) by Mrs. L. Whitaker, outside the Lacandona area. Precise localities are mentioned whenever available; but some species have been recorded thus far merely from "Chiapas." Species of doubtful occurrence or identification have been omitted. The general distribution out-

side the State has been added. Asterisks mark the species which I have seen from Chiapas.

Helicina ghiesbreghti Pfeiffer, 1856. Chiapas. Known also from Tabasco, Guanajuato and Guatemala.

Tomocyclus gealei Crosse and Fischer, 1872. Chiapas. Known also from Guatemala.

Amphicyclotus texturatus (Sowerby, 1850). Chiapas: Chiquihuite, 6200 ft.; Escuintla, Sonconusco. Known also from Veracruz and Guatemala.

Amphicyclotus megaplanus Morrison, 1955. Chiapas: El Ocote, S. of Ocozocoautla.

**Choanopoma chiapasense* Crosse and Fischer, 1877, Chiapas.

**Choanopoma sumichrasti* Crosse and Fischer, 1874. Chiapas: El Sumidero near Tuxtla-Gutiérrez, 1300 m. (R. A. Paynter, Jr.).

Chondropoma vespertinum (Morelet, 1851). Chiapas: Palenque.

**Pachychilus chrysalis* (Brot, 1872) (= *Melania larvata* Brot, 1877). Chiapas: San Pedro in the Cerro de la Gineta; Ixtacomitan. Reported also from Nicaragua by von Martens.

**Pachychilus pyramidalis* (Morelet, 1849). Chiapas: Meyapoc near Ocozocoautla, 1000 m. (R. A. Paynter, Jr.); Rancho El Edén, 2 miles from Ocozocoautla (Mrs. L. Whitaker); Palenque. Also the var. *maximus* (Lea, 1851) from Lake Tzibal, about 50 miles west of Tenosique (D. W. Amram, Jr.). The species is known also from Tabasco, Guatemala and the Republic of Honduras.

**Physa berendti* Strebel, 1874. Chiapas: Río Amarillo at the Sumidero near Las Casas (Mrs. L. Whitaker). Known also from Puebla, Jalisco, Mexico City, Veracruz, Tabasco and Oaxaca.

Vaginula moreleti (Crosse and Fischer, 1872). Chiapas: Palenque.

**Succinea brevis* Pfeiffer, 1850. Chiapas: El Real, 600 m. (R. A. Paynter, Jr.). Known also from Mexico City and the State of Hidalgo.

Lamellaxis gracilis (Hutton, 1834). Chiapas. World-wide in the Tropics; spread by man.

Lamellaxis (?) *semistriatus* (Morelet, 1851). Chiapas: Palenque.

Pseudosubulina (?) *chiapensis* (Pfeiffer, 1856). Chiapas.

Pseudosubulina (?) *trypanodes* (Pfeiffer, 1856). Chiapas.

**Spiraxis nitidus* (Strebel, 1882). Chiapas: El Sumidero near Tuxtla-Gutiérrez, 1300 m. (R. A. Paynter, Jr.). Known also from Veracruz.

Spiraxis sulciferus (Morelet, 1851). Chiapas: Palenque. Known also from Veracruz and Guatemala.

Salasiella pulchella (Pfeiffer, 1856). Chiapas. Known also from Costa Rica.

Streptostyla dubia (Pfeiffer, 1856). Chiapas.

**Streptostyla oblonga* (Pfeiffer, 1856). Chiapas: El Sumidero near Tuxtla-Gutiérrez, 1300 m. (R. A. Paynter, Jr.).

**Streptostyla streptostyla* (Pfeiffer, 1846). Chiapas: El Sumidero near Tuxtla-Gutiérrez, 1300 m. (R. A. Paynter, Jr.).

Streptostyla irrigua var. *shuttleworthi* (Pfeiffer, 1857). Chiapas. Known also from Veracruz and Tabasco.

Streptostyla lurida (Shuttleworth, 1852) (= *S. bocourti* Crosse and Fischer, 1868; *S. lurida* var. *major* von Martens, 1891). Chiapas. Known also from Veracruz, Tabasco, Guatemala and Costa Rica.

Streptostyla nebulosa Dall, 1896. Chiapas: San Cristóbal.

Polygyra chiapensis (Pfeiffer, 1856). Chiapas.

**Polygyra yucatanca* var. *helictomphala* (Pfeiffer, 1856). Chiapas: El Real, 600 m. (R.A. Paynter, Jr.). Known also from Guatemala.

Hawaiia minuscula (A. Binney, 1840). Chiapas: Palenque. Nearly world-wide in the Tropics; spread by man.

**Omphalina zonites* (Pfeiffer, 1846). Chiapas: El Sumidero near Tuxtla-Gutiérrez (R. A. Paynter, Jr.).

Pseudohyalina cidariscus von Martens, 1892. Chiapas: Palenque.

Drymaeus chiapasensis (Pfeiffer, 1866) (= *Otostomus chiapensis* von Martens, 1893). Chiapas: Cumbre de Manzanilla. Known also from Veracruz and Puebla.

Drymaeus recluzianus (Pfeiffer, 1847). Chiapas. Known also from Costa Rica (var. *martensianus* Pilsbry, 1899).

**Drymaeus ghiesbreghti* (Pfeiffer, 1866). Chiapas: the Sumidero near Las Casas (Mrs. L. Whitaker). Known also from Colima, Oaxaca and Guatemala.

**Eucalodium decollatum* var. *ghiesbreghti* (Pfeiffer, 1856).

Chiapas. Known also from Guatemala.

**Eucalodium walpoleanum* Crosse and Fischer, 1872. Chiapas: Palenque. Known also from Guatemala.

Eucalodium sumichrasti Crosse and Fischer, 1878. Chiapas.

Coelocentrum attenuatum (Pfeiffer, 1856). Chiapas. Possibly only a variant of *C. tomacella* (Morelet).

Coelocentrum clava (Pfeiffer, 1856). Chiapas. Possibly only a variant of *C. tomacella* (Morelet).

Coelocentrum nelsoni Dall, 1897. Chiapas: Tuxtla-Gutiérrez.

Coelocentrum pfefferi Dall, 1897. Chiapas: Ocozocoautla, 1200 m.

Holospira berendti (Pfeiffer, 1866). Chiapas. Known also from Veracruz.

Epirobia berendti (Pfeiffer, 1866). Chiapas.

Epirobia gassiei (Pfeiffer, 1867). Chiapas. Possibly not separable from *E. berendti.*

**Lysinoë ghiesbreghtii* (Nyst, 1841). Chiapas: Zinacantan, 2000 m. (R.A. Paynter, Jr.); Rancho Nuevo, 8 miles from Las Casas (Mrs. L. Whitaker); mountain above the Sumidero near Las Casas (Mrs. L. Whitaker). Known also from Guatemala, the Republic of Honduras, and El Salvador (Volcán de Santa Ana)

**Xanthonyx chiapensis* (Pfeiffer, 1856). Chiapas.

Elliptio sentigranosus (von dem Busch, 1845) (= *Unio corium* Reeve, 1864). Chiapas. Known also from Veracruz.

Elliptio (*Nephronaias*) *calamitarum* (Morelet, 1849); including var. *prolongata* Fischer and Crosse, 1894; var. *nephretica* Fischer and Crosse, 1894; and var. *arcuana* Fischer and Crosse, 1894. Chiapas: Baluntie River near Palenque.

Elliptio (*Nephronaias*) *aeruginosus* (Morelet, 1849). Chiapas: Michol River near Palenque.

Anondontites bambousetarum (Morelet, 1851). Chiapas: Palenque.

IV

ANTS FROM LAGUNA OCOTAL (HYMENOPTERA: FORMICIDAE)

By

William L. Brown, Jr.

The ants from Laguna Ocotal were collected for the most part by Robert L. Dressler, and, unless otherwise indicated, the collections were made from epiphytes, particularly bulbous-based *Tillandsia,* growing in the pine forest or the adjacent tropical evergreen forest. Among the 21 species represented in the collection, 17 can be determined to species in accordance with present-day classifications; the remainder belong to difficult groups in need of revision, or else the sample is in some way unsatisfactory for species determination, so that identification is carried only to genus.

All of these species belong to the tropical American fauna, and all are either widespread in South and Central America or else range at least through Central America and extend northward into Veracruz and neighboring Mexican states. Very few ants have been recorded from Chiapas (see Brown, 1950, Wasmann Jour. Biol., 8: 241-250), but with the present series we have accumulated a sample sufficient to confirm the expected close similarity of the Chiapas ant fauna to those of Guatemala and Veracruz. A few of the records of ants received from E. O. Wilson, collected by him in Veracruz during 1953, are mentioned below where relevant. I also possess a small number of Chiapas ants collected by C. J. Goodnight and L. J. Stannard during the last five years, mostly from soil and leaf-litter berlesates, including new species of dacetines and basicerotines that will be described elsewhere. The soil and soil-cover samples are, of course, quite different from the epigaeic-arboreal collections reported below; on the forest floor, *Wasmannia auropunctata* (Roger), small species of *Pheidole* and *Solenopsis, Prionopelta modesta* Forel, and several of the smaller Dacetini are the commonest forms, present in nearly every Berlese sample taken, while *Pachycondyla harpax* (Fabricius), *Ponera nitidula* Emery, *Ponera* spp., and *Brachymyrmex* are rather frequent.

As is well known, some of the forms listed below have been involved in considerable taxonomic uncertainty, due chiefly to unrecognized synonymy. Wherever such synonymy has become obvious from the augmented samples now available in the Museum of Comparative Zoology, I have taken the minimum formal steps necessary to list and justify it.

Platythyrea punctata F. Smith

From a nest in a fallen log, August 3. Winged forms were present, the males being fully pigmented and apparently active, while most of the females were still in the callow stage or were not yet eclosed. Wilson found this ant foraging on tree trunks after dark in Veracruz and Cuba; the nocturnal tree-climbing habit seems characteristic of many members of tribe Platythyreini.

Typhlomyrmex rogenhoferi Mayr

Typhlomyrmex rogenhoferi Mayr, 1862, Verh. zool.-bot. Ges. Wien. 12: 737, worker. Type locality: Amazonas.

Typhlomyrmex rogenhoferi race *robustus* Emery, 1890, Bull. Soc. Ent. Ital., 22: 40, worker. Type locality: Alajuela, Costa Rica. NEW SYNONYMY.

Typhlomyrmex robustus subsp. *manco* Wheeler, 1925, Ark. f. Zool., 17A (8): 2, worker. Type locality: Pablobamba, Peru. NEW SYNONYMY.

Prionopelta marthae Forel, 1909. Deutsch. ent. Zeitschr., p. 240, worker. Synonymy by Brown, 1953, Psyche, 59: 104.

This species is very widespread in the forested regions of tropical America, but a single female stray from a log is the first sample so far recorded from Chiapas. Series from different nests from many localities in the Museum of Comparative Zoology show wide diversity in size and in allometric characters, including relative head width, general robustness of body, and sculpture. However, there is often considerable variation in these characters within single nest series, and one particular series, from San Juan Pueblo, Honduras, leg. W. M. Mann, contains extremes of the variation as well as all intergrades; bracketed are the "diagnostic" characters for *robustus* and *manco,* as reviewed for types and metatopotypes, or both, of these two variants before me.

Neoponera lineaticeps Mayr

A small colony of this rather uncommonly collected ant was taken from a *Tillandsia* base, which is apparently a preferred habitat. It has been taken in Veracruz and Costa Rica on several occasions, but this is the first record from Chiapas. The specific name derives from the peculiar coarse, regular longitudinal striation covering the central part of the upper surface of the head, a feature that will identify the species at a glance under magnification.

Neoponera apicalis (Latreille)

Formica flavicornis Latreille, 1802, Hist. Nat. Fourmis, p. 202, pl. 7, figs. 42B, 43 (?), worker, female, *nec* Fabricius. NEW SYNONYMY.

Formica apicalis Latreille, 1802, *ibid.*, p. 204, pl. 7, fig. 42A (?), worker.

Neoponera Latreillei Forel, 1905, Ann. Soc. Ent. Belg., 49: 161, *nom. pro N. flavicornis* (Latreille). NEW SYNONYMY.

Neoponera apicalis var. *verenae* Forel, 1922, Rev. Suisse Zool., 30: 90, worker. NEW SYNONYMY.

A single worker was taken foraging on an epiphyte. This species and the closely related *N. obscuricornis* Emery have been confused through the literature, and the confusion extends to most of the ant collections rich in neotropical material to this day. The outstanding differences between these two species as I see them are: (1) *N. apicalis* has the five or six apical funicular segments a bright, contrasting yellow, whereas in *N. obscuricornis,* the apex of the funiculus is little or not at all lightened, and does not form a sudden contrast with the rest of the antenna. Faded or teneral specimens may seem to be intermediate, but these are rare and are easily identified by the remaining characters. (2) *N. apicalis* has the sides of the petiolar node nearly flat, scarcely or not at all concave or sulcate just next to the posterolateral angles, so that these angles are blunt, whereas in *obscuricornis,* the same angles are thrown into relief by a slight but distinct sulcation extending along the posterior sides of the node from top nearly to base. (3) Of the two species, *apicalis* is slightly but distinctly larger on the average, though there is some overlap in size between the two forms. (4) *N. apicalis* is more opaquely sculptured than is *N. obscuricornis,* though both species are strongly opaque; direct comparison is really

needed to reveal the difference. A study of numerous nest series, in addition to stray workers, convinces me that the foregoing characters are consistently linked in one or the other combination. No difficulty has arisen in assigning fresh worker specimens to one or the other species, and no intergrades have been seen, despite the fact that the two species frequently occur in close proximity over a vast area reaching from the Amazon Basin to southern Mexico. In the Museum of Comparative Zoology, collections of both species at single localities have been made as follows: Kartabo and Kamakusa, British Guiana, leg. W. M. Wheeler; Barro Colorado I., Panama Canal Zone, leg. N. Banks; Laguna Encantada, Veracruz, leg. Q. Jones and R. L. Dressler; Pueblo Nuevo, near Tetzonapa, and Las Hamacas, near Santiago Tuxtla, both in Veracruz, leg. E. O. Wilson. Both species live in plant cavities in arboreal situations, but nothing has been recorded concerning their ecological occurrence in any detail.

While it seems clear enough that two and only two species exist in this complex, the application of names to these entities is still in some doubt. The earliest recognized description of a member of the complex appeared when Latreille claimed to have described two species at once, giving them the names *flavicornis* and *apicalis*. The former name was supposed by Latreille to apply to a *Formica flavicornis* earlier named by Fabricius, but Fabricius' insect is apparently an attine species having nothing to do with *Neoponera; flavicornis* is thereby a preoccupied name. Nearly everything about Latreille's characterization of *flavicornis* and *apicalis* is either confused or patently in error, and the confusion extends to the correspondence of the plate figures with their respective descriptions. No reliable difference is mentioned or shown by Latreille that will serve to separate the two forms, and the description of the antennal coloration, if nearly accurate, would indicate that both are referable to *apicalis* in the present sense. This is my interpretation, made without recourse to types, but a thorough examination of the original references in conjunction with fairly good samples of the complex shows that it is the simplest solution to a problem that bothered Latreille, Emery, and Wheeler, among others, to the point where the essentially simple species-to-species relationship became lost to view. The name *latreillei* is an objective synonym

of *flavicornis*. I do not follow Emery's "Genera Insectorum" assignment of *latreillei* as a variety of *obscuricornis* — an assignment which expressed his lack of confidence in *latreillei* as a named entity in his characteristically mild, but in this case totally confusing, fashion. The variety *verenae* was described by Forel in his familiar "final melange" paper of 1922, in which several other formicid variants, since synonymized by various authors, were named on the basis of the most doubtful-appearing evidence. Forel mentions no character that would serve to distinguish *verenae* from typical *apicalis*, and *verenae* comes from the middle of the range of the species.

Neoponera unidentata (Mayr)

Pachycondyla unidentata Mayr, 1862, Verh. zool.-bot. Ges. Wien, 12: 720, worker, female.

Neoponera unidentata var. *rugosula* Emery, 1902, Rend. Accad. Sci. Ist. Bologna, (n.s.) 6: 30, worker; variant spellings are "*rugatula*" of Santschi and "*rugulosa*" of Wheeler. NEW SYNONYMY.

Neoponera unidentata, Wheeler, 1929, Zool. Anz., Wasmann-Festband, pp. 29-30, typical form, with the following varieties: var. *eburneipes* Wheeler, p. 29, worker, female. NEW SYNONYMY. var. *maya* Wheeler, p. 30, worker. NEW SYNONYMY. var. *trinidadensis* Wheeler, p. 30, worker. NEW SYNONYMY.

Wheeler conceived the named variants above (plus also the "subspecies" *sulcatula* Santschi, *q.v. infra*, which belongs in the *crenata*, not the *unidentata*, complex) as "local varieties" based on differences in color, sculpture, form of petiole, pilosity and some lesser details. There is no doubt that variation exists in these various features, and it is clear that both Emery and Wheeler understood that the variation was graded from series to series even in the limited samples examined by these authors. It is also clear, from the present augmented sample drawn from many parts of the species distribution, that the different characters do not vary according to the same geographic plan. The region of the Upper Amazon Basin shows the strongest variation, especially in sculpture, and the range of the variation there leaves little encouragement for racemakers. While it is possible to trace some series to their general area of origin by the study of trends in individual characters, other samples are ambiguous or contradictory in the display of the same characters. Clearly,

a study of geographical variation by individual characters is required before further attempts are made to classify the populations making up *N. unidentata.*

At the Laguna Ocotal collecting area, the species is characterized in general by a petiolar node a bit less thick from front to rear, as viewed from the side, than in the average Amazonian series. However, I am unable to separate some samples in the Chiapas lot from some taken in the Amazon-Guianas region. According to the locality and the characteristics of the most extreme examples, I suppose the Chiapas series would fall under Wheeler's concept of var. *maya.* This species is common in bulbous-based *Tillandsia* at the Laguna, if Dressler's collections are a fair indication of relative abundance.

N. unidentata and *N. crenata* (Roger), and also *N. carinulata* (Roger), range widely over tropical America. All three inhabit plant cavities, and all are very similar in general habitus, but the types of petiolar node formation are widely divergent.

Neoponera crenata (Roger)

Ponera crenata Roger, 1861, Berlin. ent. Zeitschr., 5: 3, female, *nom. pro Poncra pallipes* Fr. Smith, 1858, p. 98 *nec* p. 87.

The series from Laguna Ocotal (and most collected elsewhere in southern Mexico) agree best with the form described by Forel as *N. stipitum,* of which a cotype rests in the Museum of Comparative Zoology. For the present, I am unable to find any satisfactory characters to separate *stipitum* from *crenata,* and I incline to the belief that a thorough study, with resort to the scattered types of these and other named variants of the complex, will see them all merged under the name *crenata.* Meanwhile, we may tentatively associate various morphological tendencies with the names attached to the several inadequate descriptions involved.

The populations of which I have samples vary widely in size from nest to nest, although intranidal variation is relatively restricted. Weakly correlated with size is the shape of the petiolar node; this correlation holds best at the extremes of the size range, but is poor in intergradient series. Larger specimens (*ca.* 11 to 12.5 mm. in TL, or total outstretched length of body, including head and mandibles) have the posterior nodal face vertical

throughout, and distinct from the dorsal face, and the compound eyes tend to be farther from the front of the sides of the head, e.g., Kartabo, British Guiana, nos. 60, 425, leg. W. M. Wheeler. These correspond to my idea of "typical" *crenata* (=*pallipes* F. Smith preocc.).

In smaller specimens, such as the Wheeler Kartabo series nos. 495, 708, 679, 286, 507, 671, 148 and 621, among many others, TL averages only 6 to 8 mm. In these, the eyes may be closer to the anterior cephalic margins and the posterior nodal face is often (not always) more convex, with the surface curving continuously into the dorsal face; such specimens correspond to *stipitum* Forel. It is worth noting that the female node, as usual among ponerines, is higher and thinner in lateral-view profile than in the workers from the same nest. This caste difference appears to have caused some confusion in the complex in the past.

A specimen from Espiritu Santo, Brazil (TL 8.8 mm.) and some others away from the Kartabo locality appear to be transitional between the large and small forms, but this would not necessarily preclude the specific distinction between two closely related forms where sympatric, as at Kartabo and elsewhere in the Amazon-Orinoco Basins (perhaps a case of "character displacement"). The intermediate forms seem to be the same as *moesta* Mayr, the var. *moesta* of authors. The polynomials *N. crenata fiebrigi* Forel, *N. crenata confusa* Santschi, *N. crenata confusa lata* Santschi and *N. unidentata sulcatula* Santschi seem from their descriptions to represent minor southern nest variants in the small-to-medium size range of the *crenata* complex; these names are almost sure to prove synonymous when properly studied. In view of the insufficiency of my present sample (though it is considerably better than exists in other collections known to me) and the difficulty of seeing all the types involved, I have left formal synonymy in this group to some future worker.

Eciton burchelli (Westwood)

Workers were taken from a raiding column near the Laguna Ocotal camp. These specimens would undoubtedly be placed as "race *parvispinum*" by Father Borgmeier; however, the head

of the largest major (soldier) in the series is dingy yellowish-white in color.

Pseudomyrmex pallidus F. Smith

A few workers from a *Tillandsia.*

Pseudomyrmex gracilis (Fabricius)

This is the common bicolored form of the species often known as var. or subsp. *mexicanus.* It may be that the bicolored form is suppressed in northern South America where other bicolorous species of similar size and appearance become common. The geographical variation of this complex, while outstandingly conspicuous, has never been carefully and thoroughly investigated.

Pheidole punctatissima Mayr

Two colonies were taken in epiphytic plants.

Pheidole spp.

Two indeterminate species of *Pheidole* were taken in *Tillandsia.* One of these is in the confusing *biconstricta* group, and the other is a much smaller species. *Pheidole* is one of the very large (1,000-plus named forms) ant genera currently "out of control" taxonomically. Until adequate revisions of these groups become available, description of isolated new species only adds to the confusion and the unrecognized synonymy. Possibly one half of the names currently remaining unchallenged in *Pheidole* are synonyms of older names, and identification of species with any certainty is hopeless in most faunas, even where helpful preliminary revisionary attempts have been published.

Procryptocerus scabriusculus Emery

A stray worker from foliage. E. O. Wilson also took a worker during 1953 at Las Hamacas, near Santiago Tuxtla, Veracruz. This and the following two cephalotine species were determined from revisionary papers on the cephalotines by W. W. Kempf. The work of Father Kempf is refreshingly sound and useful as

compared to the majority of publications on neotropical ants with which the would-be identifier has to grapple.

Paracryptocerus cristatus (Emery)

A stray soldier. E. O. Wilson took a colony of this species at Las Hamacas, Veracruz, on August 27, 1953, occupying three internodes of a living *Cecropia* tree about 15 feet tall in tropical evergreen forest.

Paracryptocerus scutulatus (F. Smith)

A soldier and workers. The species is widespread from southern Mexico to Venezuela.

Smithistruma epinotalis (Weber)

This little dacetine normally lives in plant cavities well above the ground. The collection at Laguna Ocotal was made from a *Tillandsia*, but collections from Veracruz, sent by N. L. H. Krauss and by E. O. Wilson, were taken from hollow twigs of standing shrubs and trees.

Acromyrmex octospinosus (Reich)

Foraging workers of this fungus-growing ant stole rice from the Laguna Ocotal camp. The species has been discussed at length by W. M. Wheeler (1937, "Mosaics and other anomalies among ants," Harvard Univ. Press. Cf. pp. 69-74), who detailed the ambiguity of the characters supposed to separate it from *A. hystrix* (Latreille). Wheeler suggested as a better separatory character the presence or absence of bilateral tubercles or carinae on the propodeal dorsum; however, Wheeler's own series of the two forms in the Museum of Comparative Zoology appear to grade through on this basis without a break.

The distinction of the "races" *echinatior* Forel, *inti* Wheeler, *volcanus* Wheeler, *ekchuah* Wheeler and *cubanus* Wheeler seems to me at least as precarious as the specific separation of *hystrix* from *octospinosus*. The differences supposed to separate these forms are weak and variable, and seem to mark mere individual or nest varieties in some cases; even if they prove later to follow

to some degree geographical trends, there seems little to be gained by placing formal names upon these samples at this time. As seems to be the case with a large number of the subspecies so far described in the animal kingdom, these examples are based on entirely inadequate samples from restricted localities, and in their description scant thought seems to have been given to the overall trends in variation of the characters within the whole species.

Azteca sp.

A small brownish form, represented by minor workers only.

Brachymyrmex obscurior Forel

Specimens from *Tillandsia* seem to agree best with descriptions and other determined material of this species, though determinations in this genus are doubtful in the absence of anything better than Santschi's revision.

Nylanderia ?guatemalensis (Forel)

This slender yellowish form is usually placed as a subspecies of *vividula*, but since the taxonomy of this genus is so poorly worked out, I feel that it is better to accord provisional species rank to those names not obviously synonyms. The *guatemalensis* syntype in the Museum of Comparative Zoology is badly damaged, rendering the comparison uncertain.

Camponotus circularis Mayr

Stray workers and a small colony or colony-fragment from *Tillandsia* plants.

V

FISHES FROM LAGUNA OCOTAL

By

Robert Rush Miller[1]

Since no special collecting equipment was available, only a very limited sample of the fish fauna of this lake was obtained. Forty-seven specimens, representing four species in three families, were secured by dipnet, bent pin, and rifle (using .22 caliber dust shot) between July 21 and August 14, 1954, by various members of the expedition. Many of the examples are twisted, with broken fins and missing scales, thus rendering a careful study difficult or impossible. One viviparous species cannot be identified with certainty to genus since no males were obtained. Although two new species appear to be represented, no suitable type material is available and further well-preserved series, including both sexes, are needed to clarify their status. The following report, therefore, is necessarily of a preliminary nature.

The specimens listed below have been divided between the Museum of Comparative Zoology and the Museum of Zoology of the University of Michigan.

Despite the small size of the collection, a most interesting fish fauna is indicated for Laguna Ocotal. Isolation no doubt has been a potent factor in the differentiation of endemic species in this remote area.

CHARACIDAE

Characins

Astyanax fasciatus (Cuvier). Banded tetra.

This is one of the widest ranging freshwater fishes of the Americas. It is known from Argentina northward on the Atlantic slope to western Texas and adjacent parts of New Mexico, and on the Pacific slope from Colombia to western Mexico (Río Armería basin of Colima and Jalisco).

[1] Museum of Zoology of the University of Michigan, Ann Arbor, Michigan.

There are 10 adults, 59 to 107 mm. in standard length. The number of anal fin-rays varies as follows: 22(4), 23(4), and 24(2). Recognition of subspecies of *A. fasciatus* is currently made largely on the basis of the anal-ray count. The above specimens could be assigned to *A. f. aeneus* (Günther) or they might be interpreted as intergrades between that lowland form and the highland subspecies, *A. f. mexicanus* (de Filippi). I prefer to postpone assignment until a good series is available from Laguna Ocotal, especially since these specimens have a more oblique mandible and more posterior dorsal fin than specimens of *A. f. aeneus* from the Usumacinta basin in Guatemala.

The following color notes were made in Ann Arbor on October 29, 1954. The fins of the three largest fish (98, 105 and 107 mm. S.L.) are bright yellow-orange to deep red-orange as follows: over seven-eighths of the pelvic fins (tips of rays clear), the anteriormost 9 rays to all of the rays of the anal fin, the outer one-half of the caudal rays (except 3 to 4 rays of each lobe, which are colored their entire lengths), and the median part of the pectoral rays (weakly colored). The dorsal fin is clear in one, faintly yellowish on the distal half in another, and yellow-orange on the same rays in the third. The seven smaller fish show weaker color on these fins or none at all.

POECILIIDAE

Livebearers

Pseudoxiphophorus bimaculatus (Heckel)

This species is known along the Atlantic slope of Middle America from Veracruz, Mexico, to Miranda, Nicaragua; its altitudinal distribution is from near sea level to about 3,500 ft.

Twenty-three young to adult specimens, 16 to 49 mm. long, including 3 mature males, were obtained. The scale crescents are conspicuously blackened. Dorsal-ray counts are as follows: 13(3), 14(12), and 15(8). According to current practice, this sample is assignable to *P. b. taeniatus* Regan (see Hubbs, 1935, Univ. Mich. Misc. Publ. No. 28: 9-10, and references cited therein), a subspecies known to range from Mexico to Honduras.

Undetermined genus and species.

There are 2 adult females of a species of poeciliid which I cannot identify with any known member of the family. In the absence of males, I am uncertain to which genus the species belongs. Reference to the Poeciliidae (rather than to some other cyprinodont family) is assured from the nature of the first 3 rays of the anal fin (unbranched) and of the neuromasts or pit organs on the scale rows (see Hubbs and Miller, 1954, Zoologica, 39 (1) : 2).

The general body form is similar to that of *Lucania parva* (Baird and Girard), a species of the oviparous family Cyprinodontidae, although it is more angulate anteriorly, both in dorsal and ventral profiles. The dorsal fin is long, containing 12 rays in each specimen; the anal fin has 9 rays. The origin of the dorsal fin is midway between the base of the caudal fin and the tip of the snout. There is a faint, dark line along the midside of the body that fades out anteriorly, and the skin beneath the anterior half of the exposed part of each scale on the back and sides shows a concentration of coarse chromatophores. There are no distinctive markings.

The mandible is short and nearly vertical, indicating a surface-feeding habit. The teeth are distinctive: those in the outer row of each jaw are large and asymmetrical (shaped like the tip of a tableknife blade), and are tilted obliquely away from the center towards the outer margin of the jaws; they are most strongly oblique nearest the midpoint of each jaw, becoming almost erect at the margins. There is a toothless gap at the midpoint in the lower jaw. Inside of each outer row of teeth is an irregular series of small, conical teeth.

The body shape, long dorsal fin, oblique mouth, and distinctive dentition comprise characters which set this species apart from any poeciliid known to me from Middle America. The jaw dentition of *Xiphophorus helleri* (Heckel) is very similar and the species in question may pertain to that genus; it does not represent that species, however, which differs in coloration, mouth width, a less oblique lower jaw, the more robust body, etc. The dentition of the outer jaws is similar also in specimens of *Phallichthys pittieri* (Meek), but the teeth of that species are more loosely attached and more numerous and other marked differences indicate no intimate relationship.

CICHLIDAE

Mojarras

Cichlasoma species

Twelve specimens, 51 to 96 mm. long, represent a species of the "Section" (or subgenus) *Parapetenia* of Regan (1906, Biologia Centrali-Americana, Pisces, 8: 26). However, I cannot place the present form with any of those treated by Regan or by subsequent authors. What remains of the color pattern is suggestive of both *C. salvini* and *C. urophthalmus,* but the Ocotal specimens otherwise differ in many ways from both of those species. There are rather definite to indistinct vertical to oblique bands along the sides, numbering not more than 10 or 11, the anteriormost 2 to 3 extending obliquely forward across the nape (as in *C. nigrofasciatum*). An irregular, usually disrupted, lateral band extends from the upper angle of the opercle, reaching backward not farther than to below the middle of the soft dorsal fin. Some specimens have a prominent black spot at the base of the upper half of the caudal fin (and lying entirely above the posterior extension of the lateral line) which is surrounded by a light area, as in *C. urophthalmus* (see Günther, 1868, Trans. Zool. Soc. London, 6: Pl. 72, fig. 1); this spot is indistinct or obsolete in other specimens. The two largest fish are entirely black (a melanistic phase?) and have a shorter pectoral fin (not reaching origin of anal), but otherwise agree with the ten smaller fish. In the latter, the pectoral fin extends to above or slightly beyond the origin of the first anal spine. It is possible that the two black specimens represent a different species, but this point cannot be determined satisfactorily on the basis of the present material.

The spinous dorsal is long and low, comprising 18 spines in 9 and 19 in 3 specimens; the soft dorsal has 9 rays in all; the anal spines are numerous: 8 in 7 and 9 in 5; and the soft rays of the anal fin vary as follows: 6(1), 7(7), 8(3), and 9(1). A narrow but definite frenum is present in each specimen and the gillrakers (total number, including rudiments) number 9(1), 10(9), and 11(2). The premaxillary spines extend posteriorly from about the front to the middle of the orbit.

The large number of dorsal and anal spines (with correspondingly few soft rays), the body form, and the coloration appear to be among the distinguishing characters of this species.

VI

REPTILES AND AMPHIBIANS FROM THE SELVA LACANDONA

By

Benjamin Shreve

As this section of the report deals only with the reptiles and amphibians collected during 1954 in the Selva Lacandona, it is perhaps fitting to mention that Raymond A. Paynter, Jr. and Robert L. Dressler collected reptiles and amphibians in other parts of Chiapas and elsewhere in Mexico. Although not included in this study, these are much appreciated.

Of those collected in Chiapas, a specimen of *Stenorhina f. freminvillii* Duméril, Bibron and Duméril from Ocosingo, should be mentioned as representing the first record of this race for the state. It will be seen that of those species discussed in the report, several are new to Mexico or to Chiapas.

It seems advisable to mention that the wholesale restriction of type localities by Smith and Taylor (1950, Univ. Kansas Sci. Bull., **33**, pp. 313-380) is not followed here because of the numerous instances of error and poor judgment, aside from being considered unnecessary. See comments of Dunn and Stuart (1951, Copeia, p. 55; and 1951, Science, **113**, p. 677).

Crocodylus moreletii Duméril and Duméril

Crocodylus Moreletii Duméril and Duméril, 1851, Cat. Meth. Rept., p. 28; Lake Petén, Guatemala.

imm. ♂ (M.C.Z. 53860) Laguna Ocotal, Aug. 12.

cranium (M.C.Z. 53903) Laguna Ocotal, July-Aug.

The remains of what appears to be an immature *Pseudemys scripta ornata* (Gray) were found in the stomach of M.C.Z. 53860, now a made up skin.

Kinosternon leucostomum Duméril and Duméril

Cinosternon Leucostomum Duméril and Duméril, 1851, Cat. Meth. Rept., p. 17; Mexico, etc.

1 (M.C.Z. 53861) Laguna Ocotal, July-Aug.

ANOLIS TROPIDONOTUS SPILORHIPIS Alvarez del Toro and Smith

Anolis tropidonotus spilorhipis Alvarez del Toro and Smith, 1956, Herpetologica, **12**, p. 9: Cerro Ombligo, 1280 m., Chiapas, Mexico.

6 (M.C.Z. 53855-7) Monte Líbano, July 16-18.
4 (M.C.Z. 53858-9) Laguna Ocotal, July-Aug.
11 (M.C.Z. 53887-91) Laguna Ocotal to El Censo, Aug. 20.
8 (M.C.Z. 53894-7) El Censo to Monte Líbano, Aug. 21.

On comparing this series with one from near El Potrero, Veracruz, identified as *tropidonotus,* I find that the former has a differently colored dewlap, smaller ventrals as compared with the dorsals, and possibly larger head scales. These are mentioned by the two authors of this new form as differences between their new race and the typical form.

ANOLIS LIMIFRONS RODRIGUEZII Bocourt

Anolis rodriguezii Bocourt, 1873, Miss. Sci. Mex., Rept., p. 62, pl. 13, fig. 1: Panzos, Alta Vera Paz, Guatemala.

3 (M.C.Z. 53862-4) Laguna Ocotal, July-Aug.

I am doubtful about the validity of *microlepis* Alvarez del Toro and Smith (1956, Herpetologica, **12**, p. 4) as a race.

ANOLIS CAPITO Peters

Anolis (*Draconura*) *capito* Peters, 1863, Monatsb. Akad. Wiss. Berlin, p. 142: Costa Rica.

2 (M.C.Z. 53865-6) Laguna Ocotal, July-Aug.
1 (M.C.Z. 53893) El Censo to Monte Líbano, Aug. 21.

This is the first record of *capito* from the state of Chiapas.

BASILISCUS VITTATUS Wiegmann

Basilicus vittatus Wiegmann, 1828, Isis von Oken, **21**, p. 373: Mexico.

1 (M.C.Z. 53850) Monte Líbano, July 16-18.
7 (M.C.Z. 53867-71) Laguna Ocotal, July-Aug.
1 (M.C.Z. 53898) El Censo to Monte Líbano, Aug. 21.

CORYTHOPHANES HERNANDEZII (Wiegmann)

Chamaeleopsis Hernandesii (*sic*) Wiegmann, 1831, Isis von Oken, **3**, p. 298: Mexico.

5 (M.C.Z. 53872-6) Laguna Ocotal, July-Aug.

Lygosoma assatum cherriei (Cope)

Mocoa cherriei Cope, 1893, Proc. Amer. Philos. Soc., **31**, p. 340: Palmar, Costa Rica.

3 (M.C.Z. 53877-8) Laguna Ocotal, July-Aug.

1 (M.C.Z. 53892) Laguna Ocotal to El Censo, Aug. 20.

Recently Mittleman (1950, Herpetologica, **6**, p. 19) proposed *Scincella* for all New World members of *Lygosoma*. However, Schmidt (1953, Check List N. Amer. Amph. Rept., p. 147) treats *Scincella* as a subgenus of *Lygosoma*, which seems a better course.

Rhadinaea decorata decorata (Günther)

Coronella decorata Günther, 1858, Cat. Snakes Brit. Mus., p. 35: Mexico.

♂ (M.C.Z. 53899) El Censo to Monte Líbano, Aug. 21.

Midbody scale rows 17; ventrals 118; subcaudals 73+.

Lampropeltis doliata polyzona Cope

Lampropeltis polyzona Cope, 1860, Proc. Acad. Nat. Sci. Philadelphia, **12**, p. 258: Cuatupe, near Jalapa, Veracruz, Mexico.

♀ (M.C.Z. 53849) Monte Líbano, July 16-18.

♀ (M.C.Z. 53879) Laguna Ocotal, July-Aug.

Midbody scale rows 21-23; ventrals 233-238; subcaudals 54+–56. This form was previously unrecorded from Chiapas.

Sibon dimidiatus (Günther)

Leptognathus dimidiata Günther, 1872, Ann. Mag. Nat. Hist. (4) **9**, p. 31: Mexico.

♀ (M.C.Z. 53882) Laguna Ocotal, July-Aug.

Midbody scale rows 15; ventrals 182; subcaudals, with some doubt, 109. James A. Peters, who is revising the *Dipsas* group, tells me this species belongs in the genus *Sibon*, and that if a subspecies is recognizable this Ocotal snake belongs to the typical form.

This specimen provides the first definite locality record for Mexico, although *dimidiatus* is known from Piedras Negras, Petén, just over the Guatemalan border.

Imantodes cenchoa leucomelas Cope

Himantodes leucomelas Cope, 1861, Proc. Acad. Nat. Sci. Philadelphia, **13**, p. 296: Mirador, Veracruz, Mexico.

♂ (M.C.Z. 53881) Laguna Ocotal, July-Aug.

Midbody scale rows 17; ventrals 249; subcaudals 161.

Coniophanes fissidens fissidens (Günther)

Coronella fissidens Günther, 1858, Cat. Snakes Brit. Mus., p. 36: Mexico.

♂ (M.C.Z. 53880) Laguna Ocotal, July-Aug.

Midbody scale rows 21. Neither ventral nor subcaudal counts can be supplied as the specimen is decayed anteriorly and much of the tail is missing. The snake was found dead.

Though this is the first Chiapas record of typical *fissidens*, as defined by Smith and Taylor (1945, Bull. U. S. Nat. Mus., **187**, p. 39), it may not have much significance as the races of this species still appear in need of revision.

Micrurus affinis apiatus (Jan)

Elaps apiatus Jan, 1858, Rev. Mag. Zool., p. 522, col. pl. 1; Vera Paz, Guatemala.

♂, ♀, imm. (M.C.Z. 53883-5) Laguna Ocotal, July-Aug.

Midbody scale rows 15; ventrals 205 (♂), 217 (♀), 226 (imm.); subcaudals 50 (♂), 41 (♀), 37 (imm.). These specimens show evidence of intergradation with *alienus*, but are nearer *apiatus*. In one snake the white blotch on the end of the snout is reduced; in another it is absent. In one the number of black body annuli is reduced to 29, which is one in excess of the maximum given for *alienus*, and one higher than the minimum for *apiatus*.

Micrurus elegans elegans ≷ veraepacis

Elaps elegans Jan, 1858, Rev. Mag. Zool. p. 524, col. pl. 2: Mexico.

Micrurus elegans veraepacis Schmidt, 1933, Zool. Ser. Field Mus. Nat. Hist., **20**, p. 32; Campur, Alta Vera Paz, Guatemala.

♀ (M.C.Z. 53900) El Censo to Monte Líbano, Aug. 21.

Midbody scale rows 15; ventrals 217; subcaudals 32. The ventral and caudal counts are intermediate between those given by Schmidt (*loc. cit.*) for the two races mentioned above.

Bothrops atrox (Linnaeus)

Coluber atrox Linnaeus, 1758, Syst. Nat. ed. 10, 1, p. 222: "Asia" (in error; restricted to Surinam by Schmidt and Walker, 1943).

♂ (M.C.Z. 53886) Laguna Ocotal, July-Aug.

Midbody scale rows 25; ventrals 212; subcaudals 70. Smith and Taylor (1945, Bull. U. S. Nat. Mus., **187**, p. 180) regard *asper* (*sic*) as a race of *atrox*, but it seems better to use the binomial pending a revision of the species. As *Bothrops* is of feminine gender, *aspera* is the proper rendering for this adjectival name when used with that genus.

Bufo marinus (Linnaeus)

Rana marina Linnaeus, 1758, Syst. Nat. ed. 10, 1, p. 211: America.

1 (M.C.Z. 28212) Monte Líbano, July 16-18.

On comparing this specimen with toads from Veracruz, Nuevo León, and Guerrero, I failed to find the differences mentioned by Taylor and Smith (1945, Proc. U. S. Nat. Mus., **95**, p. 551) as distinguishing their Chiapas material from the rest of their Mexican toads, although they referred all to *Bufo horribilis* Wiegmann. These authors fail to state how *horribilis* differs from the several other forms that undoubtedly have been included in what is conventionally regarded as *marinus*, whose type locality was probably Surinam. Head and body length 150 mm.

Bufo valliceps Wiegmann

Bufo valliceps Wiegmann, 1833, Isis von Oken, **26**, p. 657: Mexico.

4 (M.C.Z. 28213-6) Monte Líbano, July 16-18.

20 tadpoles (M.C.Z. 28239) Laguna Ocotal, July-Aug.

13 (M.C.Z. 28240-4) Laguna Ocotal to El Censo, Aug. 20.

4 (M.C.Z. 28251-4) El Censo, Aug. 20.

6 (M.C.Z. 28259-63) El Censo to Monte Líbano, Aug. 21.

The tadpoles are only tentatively referred to this species.

Leptodactylus mystaceus labialis (Cope)

Cystignathus labialis Cope, 1877, Proc. Amer. Philos. Soc., **17**, p. 90: Probably Mexico.

1 (M.C.Z. 28255) El Censo, Aug. 20.

This form seems to differ from typical *mystaceus* only in size, while no differences at all could be detected between *mystaceus* and the West Indian *albilabris*. Possibly some color differences might be found with living material.

Eleutherodactylus alfredi conspicuus Taylor

Eleutherodactylus conspicuus Taylor, 1945, Proc. U. S. Nat. Mus., **95**, p. 567: Piedras Negras, Petén, Guatemala, near Mexico-Guatemalan border.

1 (M.C.Z. 28224) Laguna Ocotal, July-Aug.

Trinomials are used as *conspicuus* is probably just the southern representative of *alfredi*. The differences between the two forms appear to be very slight. Although the type locality of *conspicuus* is in nearby Petén, this is the first time that this subspecies has been recorded from Mexico.

Eleutherodactylus laticeps (Duméril)

Hylodes laticeps Duméril, 1853, Ann. Sci. Nat. Paris (3), zool., **19**, p. 178: Yucatán, Mexico.

1 (M.C.Z. 28220) Monte Líbano, July 16-18.
7 (M.C.Z. 28225-9) Laguna Ocotal, July-Aug.
2 (M.C.Z. 28245-6) Laguna Ocotal to El Censo, Aug. 20.

These specimens agree closely with Kellogg's description of *laticeps* (1932, Bull. U. S. Nat. Mus., **160**, pp. 93, 106), which was taken from the unique type. Kellogg does not mention the length of the tarsal fold, which in our material extends from about one-half to two-thirds the length of the tarsus. The entire underside of the lower jaw and throat, *not* just the sides of the throat as in the type, is stippled with brown. In one specimen (M.C.Z. 28246) the usual black side of the upper jaw is reduced to a spot under the eye.

The largest example (M.C.Z. 28227) has a head and body length of 78 mm. The much larger size of *laticeps* and its somewhat different coloring seem to be the chief characters separating it from the closely related Central American *E. gollmeri* (Peters). But in color *gollmeri* sometimes shows the same variation as is described above for M.C.Z. 28246.

Eleutherodactylus rugulosus (Cope)

Liyla rugulosa Cope, 1869, Proc. Amer. Philos. Soc., **11**, p. 160: Pacific region of the Isthmus of Tehuantepec, Mexico.

1 (M.C.Z. 28221) Monte Líbano, July 16-18.
2 (M.C.Z. 28222-3) Laguna Ocotal, July-Aug.
4 (M.C.Z. 28247-50) Laguna Ocotal to El Censo, Aug. 20.
1 (M.C.Z. 28258) El Censo to Monte Líbano, Aug. 21.

All are subadult so that some are referred to *rugulosus* with considerable doubt.

Hyla loquax Gaige and Stuart

Hyla loquax Gaige and Stuart, 1934, Occ. Pap. Mus. Zool. Univ. Michigan, no. 281, p. 1: Ixpuc Aguada, north of La Libertad, Petén, Guatemala.

♂ (M.C.Z. 28238) Laguna Ocotal, July-Aug.

The color pattern differs somewhat from that of our two paratypes and the original description. A blackish suffusion on the dorsum extends forwards about as far as the insertion of the forelimbs, the anterior border being nearly straight; head and body length 41 mm. Although known from Piedras Negras, Petén, just across the Guatemalan frontier, this is the first record from Chiapas.

Hyla phaeota cyanosticta Smith

Hyla phaeota cyanosticta Smith, 1953, Herpetologica, **8**, p. 150: Piedras Negras, Petén, Guatemala.

3 (M.C.Z. 28217-9) Monte Líbano, July 16-18.

The largest of these unquestionably belongs to this race. The two smaller examples (M.C.Z. 28218-9) are less certain. They do not show the reticulation or spotting on the limbs and sides displayed by the large specimen.

This constitutes the first Mexican record for both the species and the race, as Smith's material came from the Guatemalan side of the Chiapas-Guatemala line (see type locality above).

Rana palmipes Spix

Rana palmipes Spix, 1824, Nov. Spec. Test. Ran., p. 29, pl. 5, fig. 1: Amazon River, Brazil.

28 (M.C.Z. 28234-7) Laguna Ocotal, July-Aug.

2 (M.C.Z. 28270) Laguna Ocotal to El Censo, Aug. 20.

1 (M.C.Z. 28256) El Censo, Aug. 20.

1 (M.C.Z. 28257) El Censo to Monte Líbano, Aug. 21.

It is likely that these Mexican frogs are subspecifically distinct from topotypic Brazilian material. A revision is needed.

Rana pipiens Schreber

Rana pipiens Schreber, 1782, Der Naturforscher, Halle, **18**, p. 185, pl. 4: Raccoon, Gloucester County, New Jersey (restricted to White Plains, New York, by Schmidt, 1953).

4 (M.C.Z. 28230-3) Laguna Ocotal, July-Aug.

Without a revision of the species, it is not known to what race the above material should be referred.

VII

BIRDS OF LAGUNA OCOTAL

By

Raymond A. Paynter, Jr.

INTRODUCTION

An investigation of the avifauna was one of the primary objectives of the Museum of Comparative Zoology expedition to the Selva Lacandona, Chiapas. Between July 21 and August 19, 1954, while at Laguna Ocotal (alt. 950 m.), 490 birds were prepared as skins. While these specimens are a good sample of the resident avifauna, there can be little doubt that additional species occur in the region but were not observed. In a heavily forested region collecting is difficult even under the most favorable conditions. We were at work at the end of the breeding season when most birds are silent and secretive – obviously the most difficult collecting period.

The following list is based on the specimens collected, as well as on unequivocal field observations. The specimens were weighed on a double-pan balance. The means of the measurements are accompanied by their standard errors (σ_m). The Hippoboscidae (bird-flies) were identified by Joseph C. Bequaert.

ANNOTATED LIST

Tinamus major robustus Sclater and Salvin

1 ♀, Aug. 7.

The species was heard on a few occasions and seen twice. The bird weighed 1090.5 grams.

Crypturellus boucardi boucardi (Sclater)

1 ♀, July 22; 1 ♂, Aug. 10; 1 ♂, Aug. 11.

Although by no means common, this is the more abundant tinamou. Occasionally it was found in the tropical evergreen forest but it occurred principally in the *monte*. The males weighed 291.4 and 403.3 grams; the female 351.0 grams.

PHALACROCORAX BRASILIANUS MEXICANUS (Brandt)

1 ♂, July 30.

On an undisturbed lake one would expect to find water birds in abundance, but the cormorant was the only exclusively aquatic form and even they were in small flocks. The weight of the bird was 1165.0 grams.

BUTORIDES VIRESCENS VIRESCENS (Linnaeus)

1 ♀, Aug. 11.

The specimen is immature and weighed 93.1 grams. Green Herons were uncommon.

SARCORAMPHUS PAPA (Linnaeus)

One was observed, within a flock of Turkey Vultures, on August 3.

CATHARTES AURA subsp.

A few vultures came to the camp at irregular intervals.

ELANOÏDES FORFICATUS subsp.

Two kites were noted on July 26 and three on August 1.

ACCIPITER STRIATUS subsp.

A single individual flew back and forth over the lake on August 16. It would seem an early date for a migrant. Probably the bird was a resident, possibly *A. s. chionogaster*.

BUTEOGALLUS URUBITINGA RIDGWAYI (Gurney)

1 ♂, Aug. 15.

This is the only example of the species which was seen. It harbored three species of Hippoboscidae: *Ornithoctona erythrocephala, Lynchia angustifrons,* and *L. wolcotti.*

I concur with Amadon (1949), and Amadon and Eckelberry (1955), that the genera *Hypomorphnus* and *Buteogallus* should be united.

Spizaëtus tyrannus subsp.

Paine, on August 17, saw a single Black Eagle-Hawk in the *selva*.

Herpetotheres cachinnans subsp.

Laughing Falcons were heard several times.

Micrastur semitorquatus naso (Lesson)

1 ♀, Aug. 17.

Although the dense, undisturbed, forests surrounding the lake appeared ideally suited for certain of the birds of prey, such as those of the genera *Micrastur, Spizastur,* and *Spizaëtus,* hawks were excessively rare. Only one example of *M. semitorquatus* was seen. It was host to the bird-flies *Ornithoctona erythrocephala* and *Lynchia wolcotti,* and weighed 749.8 grams.

Micrastur ruficollis guerilla Cassin

1 ♂, Aug. 14.

The specimen was taken in the low forest near the edge of the lake. On several occasions others were found in the thickest parts of the evergreen forest.

Falco rufigularis subsp.

On August 10 a pair of Bat Falcons flew near the camp, where they could be seen distinctly.

Crax rubra rubra Linnaeus

1 ♂, 1 ♀, Aug. 8; 1 ♀, Aug. 15.

Curassows were fairly abundant but not so numerous as guans. The specimen collected on August 15 is about one-third grown.

Penelope purpurascens purpurascens Wagler

1 ♂ ?, July 24.

Guans were common, ranging through all types of forest, but were most abundant where the pine and broadleaf forests met. In

the early morning they were often perched in the pines where apparently they had spent the night. *Ornithoctona erythrocephala* was taken from the specimen.

ORTALIS VETULA VETULA (Wagler)

1 ♂, July 26; 1 ♀, Aug. 1; 1 ♂, Aug. 6; 1 ♀, Aug. 7; 1 ♀, Aug. 8; 2 ♂, 1 ♀, Aug. 10; 1 ♂, Aug. 14; 2 ♀, Aug. 15; 1 ♂, 3 ♀, Aug. 16.

Chachalacas were very abundant in the transition zone between the broadleaf forest and the pines, and in the *monte* at the end of the lake. Specimens of *Ornithoctona erythrocephala* were obtained from four birds and *Lynchia plaumanni* from one. Six males ranged in weight from 319.1 to 448.5 grams, with a mean of 402.30±16.82; nine females from 309.6 to 394.8, with a mean of 356.21±10.31 grams.

ODONTOPHORUS GUTTATUS (Gould)

2 ♂, July 25; 1 ♀, July 30; 1 ♀, Aug. 12.

Wherever the floor of the forest is dark these birds were seen with fair regularity. The two males weighed 284.0 and 286.9 grams; the two females 314.1 and 316.3 grams.

ARAMUS GUARAUNA DOLOSUS Peters

1 ♀, Aug. 1; 1 ♀, Aug. 11.

There seems to be no specific record of the species in Chiapas, although Alvarez del Toro (1952) mentions that it is abundant in the state. The shores of the lake are strewn with the empty shells of the snail *Pomacea flagellata,* the preferred food of limpkins, suggesting the presence of many of these birds. However, none was heard and just a few lone individuals were seen.

ARAMIDES CAJANEA subsp.

A wood rail called in the evening of July 30. This is another species which had been expected to occur in large numbers but which was inexplicably rare.

LATERALLUS RUBER (Sclater and Salvin)

1 ♂, 1 ♀, July 21.

In the marshes near the camp, Ruddy Rails abounded, although they were seldom seen. Their call is a rattle, similar to that of a

small kingfisher, but somewhat slower. The male is an adult and weighed 49.0 grams. The female retains a portion of the immature plumage and weighed 40.5 grams. Elsewhere (Paynter, 1955) I have given my reasons for recognizing no subspecies of *L. ruber*.

Columba nigrirostris Sclater

1 ♂, Aug. 4; 1 ♂, 1 ♀, Aug. 7; 1 ♂, Aug. 11; 1 ♂, Aug. 12; 1 ♀, Aug. 15.

Short-billed Pigeons were heard frequently, and sometimes could be seen in the tallest trees of the broadleaf forest. The specimens, however, were taken principally in the low forest and edges where they came to feed in fruiting trees.

The males weighed 154.3, 154.4, 159.0, and 166.1 grams; the females 132.5 and 148.2 grams.

Leptotila cassinii cerviniventris Sclater and Salvin

1 ♂, July 22; 1 ♀, July 25; 1 ♂, July 30; 1 ♂, July 31.

Although the species has been recorded in Mexico only from Santa Rosa, Comitán, Chiapas (Berlioz, 1939) and from two localities on the Río Usumacinta in Tabasco (Brodkorb, 1943), it was reasonably abundant in the deep forest at Laguna Ocotal. The apparent absence of *Leptotila verreauxi* and *L. plumbeiceps*, species which are widely distributed in southern Mexico, was surprising. However, most forms of *Leptotila* are secretive and difficult to collect and I would feel certain of the absence of these species only if more time had been spent in the field.

Two adult males and a female weighed 167.2, 176.5, and 152.1 gram, respectively; a female in juvenal plumage 138.0 grams.

Ara macao (Linnaeus)

Small flocks of Scarlet Macaws flew over quite regularly in the morning and evening. They did not seem to feed in the vicinity of the lake and, as a consequence, alighted rarely, and then only in the tops of tall pines or on conspicuous dead trees in the *selva*.

PIONUS SENILIS SENILIS (Spix)

1 ♀, Aug. 14; 1 ♀, Aug. 16.

Although parrots passed over each day at dawn and dusk, they were nearly absent from the forest surrounding Laguna Ocotal. Late in our stay a small flock of *Pionus senilis* began to roost for the night in the pines at the edge of the broadleaf forest on the eastern side of the lake. It is from this group that the specimens were secured. The birds weighed 220.4 and 221.5 grams.

The genus *Amazona* was represented in the flocks of parrots seen in the air. *A. ochrocephala* was tentatively identified, but another species seemed to be present also; there may have been still others.

PIAYA CAYANA subsp.

On August 12 there was a Squirrel Cuckoo in the top of a pine standing in small clearing. No other was observed.

NYCTIDROMUS ALBICOLLIS YUCATANENSIS Nelson

1 ♂, July 29; 1 ♂, Aug. 10; 1 ♀, Aug. 17.

Common within the burned area in the pines. The males weighed 65.5 and 68.5 grams; the female 74.5 grams.

PHAETHORNIS SUPERCILIOSUS LONGIROSTRIS (DeLattre)

1 ♀, July 31; 1 ♂, Aug. 9.

No approach to *P. s. veraecrucis* is exhibited by the specimens, although birds from Palenque, which is about 100 kilometers to the north, either were referred to that race (Brodkorb, 1943, Tashian, 1952) or said to be intermediate (Friedmann, Griscom, and Moore, 1950). The weight of the male was 6.4 grams; that of the female 5.9 grams. Dressler reported seeing one of these hummingbirds feeding at a dwarf *Heliconia* (*H. tortuosa* Griggs), a plant with red bracts and long, curved, yellow flowers, for which the bird's bill is well suited.

ABEILLIA ABEILLEI ABEILLEI (Lesson and DeLattre)

1 ♀, July 27; 1 ♂, 1 ?, Aug. 8.

The female weighed 3.5 grams; the male, which is immature, 3.0 grams. No adult males were seen.

Amazilia candida candida (Bourcier and Mulsant)

1 ♀, Juy 24; 1 ♂, Aug. 11.

The male and female weighed 3.8 and 3.6 grams, respectively. This species and the females and immature males of *Abeillia abeillei* were impossible to differentiate in the field; their relative abundance is not known. Among the least common hummingbirds, they occurred in the high broadleaf forest in localities where the sun reaches the ground and encourages the growth of flowering plants and shrubs.

Amazilia beryllina devillei (Bourcier and Mulsant)

1 ♂, Aug. 11.

The specimen displays none of the characters ascribed to *A. b. lichtensteini* or to the nominate race and is, therefore, the first record of *A. b. devillei* from the Atlantic slope of Chiapas. It was taken in the tropical evergreen forest and was the only example seen. It weighed 4.6 grams.

Eupherusa eximia eximia (DeLattre)

1 ♂, July 24; 1 ♂, 1 ♀, July 25; 1 ♂, July 26; 1 ♀, July 27; 1 ♂, July 29; 2 ♂, July 30; 1 ♂, 1 ♀, Aug. 1; 2 ♂, Aug. 2; 2 ♀, Aug. 3; 1 ♂, Aug. 4, 1 ♂, Aug. 6; 1 ♂, Aug. 7; 2 ♂, Aug. 8; 1 ♀, Aug. 9; 2 ♂, Aug. 10; 1 ♂, Aug. 13; 1 ♀, Aug. 14; 1 ♂, Aug. 16; 1 ♀, Aug. 17; 1 ♂, Aug. 19.

Where there were plants flowering in the tall broadleaf forest this hummingbird was almost always present. It was by far the most common Trochilid. Twenty males ranged from 3.5 to 4.7 grams, with a mean of 4.18±.06; seven females from 3.0 to 4.0 grams, with a mean of 3.65±.14.

Lampornis viridi-pallens viridi-pallens (Bourcier and Mulsant)

1 ♂, July 23; 2 ♂, 1 ♀, July 27; 1 ♀, July 31; 1 ♂, Aug. 1; 1 ♀, Aug. 5; 1 ♀, Aug. 6; 1 ♂, Aug. 9; 2 ♂, Aug. 11.

These hummingbirds occurred in the same biotope as *Eupherusa eximia* and were almost as numerous.

I have examined 15 specimens of the species from and near

Mt. Ovando, Chiapas, the type locality of *L. v. ovandensis,* and conclude that, although recognizable, it is an extremely weak race. The coloration of the dorsal surface is variable and no consistent difference between the two races is distinguishable. The bill length is also inconstant; there appears to be a complete overlap between the forms in this character. The only differentiating features I can appreciate are the faintly lighter abdomen and slightly greater area of white on the lower throat of *L. v. ovandensis.*

Seven males ranged in weight from 5.3 to 6.5 grams, with a mean of 5.80±0.14 grams. Four females weighed 4.7, 4.7, 4.8, and 5.2 grams.

Trogon massena subsp.

A single bird was seen on August 15 in a fruiting tree at the edge of the pines.

Trogon collaris puella Gould

1 ♂, July 21; 1 ♀, Aug. 5; 1 ♂, Aug. 12.

Within the heavy forest this species was noted with regularity, but it was uncommon.

The males weighed 63.7 and 64.5 grams; the females 63.4 grams. It is of interest to compare these weights with those obtained on the Yucatán Peninsula (Paynter, 1955). There two males weighed 47.6 and 53.5 grams, and two females 41.1 and 53.9 grams. This suggests that the Peninsular birds are smaller in mass, although no differences in linear measurements are evident. A larger series is needed to confirm the proposal.

Trogon violaceus braccatus (Cabanis and Heine)

1 ♀, Aug. 6.

The specimen, the only one of the species seen, was collected in the transition forest. It weighed 57.1 grams.

Chloroceryle americana septentrionalis (Sharpe)

1 ♂, July 25; 1 ♀, Aug. 3; 1 ♀, Aug. 5; 1 ♂, Aug. 9.

Two adult females and a male weighed 40.7, 43.1, and 39.7 grams, respectively; an immature male 37.3 grams.

Chlorocervle aenea stictoptera (Ridgway)

1 ♀, Aug. 10; 1 ♂, Aug. 11; 1 ♂, Aug. 15.

Both species of kingfisher were common. The two males weighed 15.5 and 16.8 grams, the female 20.8 grams.

Hylomanes momotula momotula Lichtenstein

1 ♂, Aug. 2; 1 ♂, 1 ♀, Aug. 3; 1 ♀?, Aug. 7.

These small motmots were seldom seen, but because of their silent, sluggish behavior may have been more numerous than it appeared.

The two males weighed 32.5 and 32.7 grams; the female 29.7 and the bird of doubtful sex 31.0 grams. None possessed more than a trace of fat. Van Tyne (1935) gave the weight of five males from Petén as ranging from 27.0 to 28.5 grams, and noted that the heaviest bird was fatty; two females weighed 26.5 and 27.5 grams. The apparent difference in weight between the two populations should be investigated when more data are available.

Momotus momota lessonii Lesson

1 ♂, Aug. 6.

No more than ten of these birds were seen during the period spent at the lake. The specimen weighed 131.6 grams, which is considerably heavier than the previously reported maximum of 119.5 grams (Van Tyne, 1935).

Tashian (1952) listed *M. m. goldmani* from Palenque, but gave no reason for resurrecting the race which Van Tyne (1935), Wetmore (1943), and Berlioz (1952), have shown to be synonymous with *M. m. lessonii*. I, too, am unable to appreciate the supposed characters of *M. m. goldmani*.

Pteroglossus torquatus torquatus (Gmelin)

1 ♂, Aug. 3; 1 ♂, Aug. 11.

The birds weighed 209.5 and 221.0 grams, further strengthening Van Tyne's (1935) assertion that the nominate race is markedly heavier than *P. t. erythrozonus*. The maximum and minimum weights recorded for *P. t. erythrozonus* are: males,

177.0 (Van Tyne, 1935) and 169.2 grams (Paynter, 1955); females, 181.1 (Paynter, 1955) and 147.0 grams (Van Tyne, 1935). Those for the nominate form are: males 240.0 and 209.5 grams (Van Tyne, 1935); female (only record) 230.0 grams (Van Tyne, 1935).

Araçaris were fairly common.

Ramphastos sulfuratus sulfuratus Lesson

1 ♂, July 30; 1 ♂, Aug. 18.

This large toucan was more abundant than *Pteroglossus torquatus.*

Van Tyne (1935) found, in Petén, the weights of males of the race range from 362.0 to 449.5 grams. These specimens weighed 483.5 and 496.4 grams and are apparently the heaviest yet recorded.

Piculus rubiginosus yucatanensis (Cabot)

1 ♂, July 23; 1 ♀, Aug. 15.

The specimens collected were the only ones seen. They exhibited no approach toward *P. r. maximus* of the mountains of Chiapas and Guatemala. The male weighed 83.0 and the female 75.4 grams.

Centurus pucherani perileucus (Todd)

1 ♀, July 29; 1 ♂, Aug. 18; 1 ♀, Aug. 19.

Within the pines this species was moderately numerous, but it usually ranged in the tops of the trees, out of gunshot. One of the specimens was collected in the pines and the other two in the zone of transition between the pine and broadleaf forests. It was rare, however, in the latter locality. The weight of the male was 53.0 grams; that of the females 48.9 and 49.4 grams.

Amadon and Eckelberry (1955), in commenting on the failure of many authors to unite *Centurus* with *Melanerpes,* as was done by Peters (1948), state that ". . . the barred (*sic*) immature plumage of the Red-headed Woodpecker (*M. erythrocephalus*) and the color pattern of *M. portoricensis,* do tie the two groups together." I fail to appreciate this. The plumage of the immature *M. erythrocephalus* is streaked, not barred, and notably

similar to that of the adult Acorn Woodpecker (*M. formicivorus*). No species of *Centurus* approximates such a condition.

M. portoricensis, an insular species presumably at the end of an evolutionary line, rather than a link, bears no resemblance to the *Centurus* group, with the exception of its red abdomen and brown sides. Dorsally it is similar to *M. formicivorus* with a glossy black back, white rump, and white forehead; it lacks only the red head of that species (and of *Centurus*). Its behavior is said to be like that of the Acorn Woodpecker (Wetmore, 1927). The coloration of the throat and upper chest of *M. portoricensis* is similar to that of *M. erythrocephalus,* even to the remnant of a black pectoral band. The extension of red to the abdomen, when the chest is red, is a small evolutionary step and is certainly a logical explanation for the existence of this character in *M. portoricensis.*

Thus, the only real similarity between this species and the *Centurus* group is the brown coloration of the sides. It seems most likely that this character was acquired independently by an *M. formicivorus*-like progenitor, which was isolated in the Antilles. Alternative explanations are that *M. portoricensis* is a primitive species exhibiting the first indications of the divergence of *Centurus* from *Melanerpes,* or, that *Centurus* is the older group and *M. portoricensis,* retaining only its brown sides, betrays the origin of *Melanerpes.* These are obviously spurious hypotheses.

It is unexpected that Amadon and Eckelberry (1955) should accept the unification of *Centurus* and *Melanerpes,* but maintain *Tripsurus,* a genus also reduced to the synonymy of *Melanerpes* by Peters (1948). It is true that the species usually placed within *Tripsurus* are separated from *Centurus* (*sensu stricto*) by gaps greater than those existing between most species of *Centurus,* but I believe the group is not of generic rank and is best considered a subgenus of *Centurus.*

Veniliornis fumigatus sanguinolentus (Sclater)

1 ♂, Aug. 4; 1 ♂, Aug. 6; 1 ♂, Aug. 12; 1 ♂, Aug. 15; 1 ♀, Aug. 17.

Where trees have fallen in the broadleaf forest, and on the edges of other clearings, there is usually a stand of shrubs and young trees. It is in such a habitat that this woodpecker is found. It is, therefore, localized and uncommon.

The female weighed 29.3 grams and the males 32.0, 34.1, 35.0, and 39.3 grams.

Phloeoceastes guatemalensis guatemalensis (Hartlaub)

1 ♂, 2 ♀, July 31; 1 ♀, Aug. 2; 1 ♂, Aug. 8.

An abundant resident in the high forest. The males weighed 234.0 and 237.0 grams; the females 222.5, 223.0, and 226.4 grams.

Dendrocincla anabatina anabatina Selater

1 ♂, July 23; 1 ♂, Aug. 7; 1 ♂, Aug. 11; 1 ♂ ?, Aug. 17.

There appears to be no specific record of this species in the state. Alvarez del Toro (1952), however, has included it in his book. The weight of three males was 34.2, 37.3, and 38.3 grams.

Dendrocincla homochroa homochroa (Sclater)

1 ?, July 23; 1 ♀, July 25; 1 ♀, Aug. 9.

Two males weighed 33.8 and 35.5 grams. Both species of *Dendrocincla* were present in moderate numbers and seemed about as common as I have found them in the rain forest of the Yucatán Peninsula.

Sittasomus griseicapillus sylvioides Lafresnaye

1 ♀, July 23; 1 ?, July 24; 1 ♂, 1 ♀, July 25; 1 ♂, Aug. 4; 1 ?, Aug. 5; 1 ♂, Aug. 8; 1 ♀, Aug. 12; 1 ♀, Aug. 13; 1 ♂, 1 ?, Aug. 14; 1 ♀, Aug. 16; 2 ♀, Aug. 17; 1 ?, Aug. 18; 1 ♂, Aug. 19.

The linear dimensions of *S. g. sylvioides* and *S. g. gracileus* have been shown to be markedly different (Paynter, 1955). It is not unexpected that a substantial difference in the average weight of the races also can be demonstrated. The weight of five males of *S. g. sylvioides* from Laguna Ocotal ranged from 12.8 to 14.2 grams, with a mean of 13.52±0.21; that of six females from 11.1 to 13.8 grams, with a mean of 12.53±0.12. On the Yucatán Peninsula, where *S. g. gracileus* is found, seven males ranged from 9.0 to 12.1 grams, with a mean of 11.01±0.35; four females from 8.6 to 10 grams, with a mean of 9.25±0.34 (Paynter, 1955).

Within the *selva* this was the most abundant of the Dendrocolaptidae.

DENDROCOLAPTES CERTHIA SANCTI-THOMAE (Lafresnaye)

1 ♀, July 26; 1 ♀, Aug. 9; 1 ♂, Aug. 13.

A bird of the high evergreen forest, but at times seen on the trunks of pines when they were adjacent to its preferred habitat. No woodhewer was more shy.

When more birds have been weighed there may be evident a difference in mass between this subspecies and *D. c. legtersi* of the Yucatán Peninsula. The male and the two females weighed, respectively, 67.3, 66.0, and 68.3 grams. Tashian (1952) found a female to weigh 63.0 grams. Paynter (1955) recorded two males of *D. c. legtersi* as weighing 52.7 and 60.8 grams, and three females of *D. c. sancti-thomae,* which exhibited an approach toward the Yucatán Peninsula endemic, as 54.3, 55.9, and 61.3 grams.

XIPHORHYNCHUS ERYTHROPYGIUS PARVUS Griscom

1 ♀, 1 ?, July 27; 2 ♀, July 31, 2 ♀, 1 ?, Aug. 1; 1 ♀, Aug. 3; 1 ♂, Aug. 4; 1 ♂, Aug. 5; 1 ♀, Aug. 6; 1 ♀, Aug. 7; 1 ♂, Aug. 16; 1 ♀, Aug. 17; 1 ?, Aug. 18.

Nine females ranged in weight from 39.7 to 43.7 grams, and had a mean of 41.78±0.43 grams. Three males weighed 43.0, 44.0, 44.9 grams. These were abundant birds in the broadleaf forest and occasionally ranged to the edge of the pines.

LEPIDOCOLAPTES SOULEYETII INSIGNIS (Nelson)

2 ♀, July 26; 1 ♀, Aug. 16; 1 ♂, Aug. 18.

L. affinis and the present species occurred sympatrically in the pines. They are morphologically so similar it was not possible to distinguish them in the field; their relative abundance is unknown. As an aggregate, however, they were not common.

An adult male and two females weighed 30.8, 29.8, 30.9 grams, respectively; a juvenal female 30.7 grams.

LEPIDOCOLAPTES AFFINIS AFFINIS (Lafresnaye)

1 ♀, Aug. 5.

It is regrettable that it was not possible to study the species carefully while in the field. *L. souleyetii* is a lowland form which usually occurs in rain forest, while *L. affinis* is found in pines or

other types of forest characteristic of the highlands. The fact that at Laguna Ocotal *L. souleyetii* abandoned the broadleaf forest for the pines suggests that it may have found a more easily exploitable niche within the conifers. Neither species was common and probably they were able to exist sympatrically without competing.

The specimen weighed 27.6 grams.

Anabacerthia striaticollis variegaticeps (Sclater)

1 ♂, Aug. 2.

The specimen, which was the only one seen, weighed 23.6 grams.

Automolus ochrolaemus cervinigularis (Sclater)

1 ♂, July 31; 1 ♂, Aug. 2; 1 ♂, Aug. 3; 1 ♂, Aug. 5; 1 ♂, Aug. 6; 2 ♀, Aug. 7; 1 ♀, Aug. 10; 2 ♂, 2 ♀, Aug. 17.

None of the Furnariidae was more abundant than this species, which was a conspicuous element of the heaviest *selva*.

Seven males ranged in weight from 44.7 to 50.4 grams, with a mean of 47.34±0.87; five females from 37.5 to 44.0 grams, with a mean of 40.48±1.12.

Xenops minutus mexicanus Sclater

1 ♀, Aug. 5; 1 ♀, Aug. 16.

Very few Plain Xenops were present. The birds weighed 10.5 and 11.8 grams.

Sclerurus mexicanus mexicanus Sclater

1 ♂, July 23; 1 ?, 1 ♀, July 24; 1 ♀, July 27; 1 ♀, Aug. 17.

These birds were seen on the average of about once a day in the most dense forest. The weight of the male and three females was 28.0, 25.0, 26.6, and 30.0 grams, respectively.

Thamnophilus doliatus intermedius Ridgway

1 ♀, July 29; 1 ♂, Aug. 4; 1 ♂, Aug. 18.

Antshrikes were restricted to the *monte* and thickets at the end of the lake. The male taken on August 4 had enlarged testes and was one of the few birds collected which showed indications of reproductive activity. The males weighed 28.4 and 28.8 grams; the female 30.0 grams.

Dysithamnus mentalis septentrionalis Ridgway

2 ♂, 1 ♀, July 24; 1 ♂, July 31; 1 ♂, Aug. 3; 1 ♀, Aug. 6.

Traylor (1941) collected two examples of this species in southern Campeche, adding the species to the known Mexican avifauna. At Laguna Ocotal, it was common, and often associated with *Myrmotherula schisticolor*, in the shrubs bordering trails through the thickest parts of the deciduous forest.

Three of the males are immature and weighed 11.6, 12.7, and 13.5 grams. An adult male and two females weighed 13.6, 12.9, and 13.8 grams, respectively.

Myrmotherula schisticolor schisticolor (Lawrence)

1 ♂, July 24; 1 ♀, Aug. 6; 1 ♂, Aug. 14; 1 ♀, Aug. 16; 1 ♂, 1 ♀, Aug. 17.

Berlioz (1939) recorded seven specimens from Santa Rosa in the district of Comitán; no other record from Mexico is known. It seemed to be localized in the forest, but often occurred in loose flocks. The respective weights of three males and three females were 7.3, 9.2, 9.2, 8.5, 8.8, and 9.6 grams.

Formicarius analis moniliger Sclater

1 ♂, Aug. 18.

Antthrushes were noted only four times but undoubtedly were more abundant than it seemed. On the Yucatán Peninsula I found them exceedingly difficult to collect during the wet season, but when the forest was dry they were heard moving about in the leaves, much like tinamous, and could be taken with little difficulty. The specimen from Laguna Ocotal was snared in a trammel net in the *monte*, although previously the species had been seen only in the high forest. It weighed 51.3 grams.

Grallaria guatimalensis guatimalensis Prevost and Des Murs

1 ♂ Aug. 1.

Only this bird was seen. Its weight was 99.0 grams.

Attila spadiceus flammulatus Lafresnaye

1 ♀, July 24.

This specimen came to a fruiting tree (*Clusia* sp.) at the camp. It was the only one noted during the month at the lake. It weighed 44.2 grams.

PLATYPSARIS AGLAIAE SUMICHRASTI Nelson

1 ♂, July 27.

The bird is almost in full adult plumage and weighed 31.5 grams. It was taken in the *monte*. No others were seen.

TITYRA SEMIFASCIATA PERSONATA Jardine and Selby

2 ♂, Aug. 9.

Masked Tityras were observed on a few occasions in the tops of pines or broadleaf trees. The birds weighed 77.9 and 86.3 grams.

PIPRA MENTALIS MENTALIS Sclater

1 ♂, July 26; 1 ♀, Aug. 2; 1 ♀, Aug. 3; 1 ♂, Aug. 5; 2 ♀, Aug. 6; 1 ♂, Aug. 15; 1 ♀, Aug. 16; 1 ♂, Aug. 18.

One of the females collected on August 16 is a fledgling barely able to fly. This species is among the latest breeders found in the region and also was one of the most common birds wherever there were bushes and small trees in the broadleaf forest. Adult males made up about one quarter of the birds seen.

Adult males weighed 17.8 17.9, and 19.1 grams; an immature male 15.8 grams; adult females 16.6, 17.1, 17.2, and 17.4 grams; a juvenal female 17.4 grams.

SCHIFFORNIS TURDINUS VERAE-PACIS (Sclater and Salvin)

1 ♀, Aug. 2; 1 ♀, Aug. 8; 1 ♂, Aug. 17.

Few of these manakins were in the area. The male and the two females weighed 32.1, 32.3, and 32.7 grams, respectively.

TYRANNUS MELANCHOLICUS CHLORONOTUS Berlepsch

1 ♂, 1 ♀, Aug. 4.

The paucity of clearings made this a very uncommon species. The few birds seen were in the pine burn or at the edge of the lake. The male weighed 41.4 grams; the bird whose sex could not be determined 36.1 grams.

MEGARHYNCHUS PITANGUA MEXICANUS (Lafresnaye)

1 ♀, Aug. 3; 1 ♂, Aug. 13.

As uncommon a bird as *Tyrannus melancholicus* and apparently for the same reasons. The weights of the male and female were 65.4 and 66.3 grams, respectively.

Myiozetetes similis texensis (Giraud)

1 ♀, Aug. 6; 1 ♀, Aug. 13.

Slightly more abundant than the preceding two species. The specimens weighed 28.0 and 33.9 grams.

Myiarchus tuberculifer connectens Miller and Griscom

1 ♂, July 26; 1 ♀, Aug. 5; 1 ♂, Aug. 10; 2 ?, Aug. 12; 1 ♂, Aug. 18.

The specimens from Laguna Ocotal are referable to *M. t. connectens,* although they are rather small and fall within the upper size range of a series of 24 specimens of *M. t. platyrhynchus,* the smallest of the races, from the Yucatán Peninsula. They are, however, dark dorsally and have varying amounts of rufous on the underside of the rectrices, two characters distinguishing *M. t. connectens* from *M. t. platyrhynchus.* The race seems not to have been reported from Chiapas, although it is to be expected along the northern and northeastern Guatemalan border.

Recently (1955) I noted that one character distinguishing *M. tuberculifer* from *M. yucatanensis* is its horn-colored, rather than black, bill. It was not realized at the time that the lighter colored bill is not always found in *M. tuberculifer. M. t. connectens* and *M. t. lawrenceii* occasionally have horned-colored bills, but in the vast majority it is black. On the other hand, within the remaining races horn-colored bills are frequent and black bills are somewhat of an exception; only *M. t. platyrhynchus,* and apparently *M. t. nigricapillus,* seem to have consistently light bills.

Enough data have accumulated so that a slight difference in weight between several races seems to be evident. Six males of *M. t. platyrhynchus* ranged from 14.7 to 19.7, with a mean of 17.15±0.74 grams; females of the race weighed 15.0, 16.0, 17.3, and 17.9 grams (Paynter, 1955). *M. t. connectens* has larger linear dimensions and the specimens from Laguna Ocotal suggest that heavier weight may be an added character. Three males weighed 19.0, 19.9, and 19.2 grams, a female 19.2 grams, and two birds of undetermined sex 18.0 and 19.1 grams. *M. t. lawrenceii,* the race with the greatest linear dimensions of the three, may also weigh the most. Paynter (1955) recorded males from Ocozocoautla, Chiapas as weighing 21.8 and 22.5 grams; Martin, Robins, and Heed (1954) found males in Tamaulipas

to weigh 21 and 22 grams. Females from Chiapas (Paynter, 1955) weighed 20.0 and 22.0 grams.

Contopus pertinax pertinax Cabanis and Heine

1 ♀, Aug. 5.

Greater Pewees were restricted to the *ocotal* where they were uncommon and much more shy than I have found them elsewhere. The bird was in heavy molt and weighed 22.0 grams.

Empidonax minimus (Baird and Baird)

1 ♂, Aug. 10.

Although this is an early date for the species, Tashian (1952) has recorded it at Palenque, Chiapas on August 6. The specimen weighed 10.6 grams.

Empidonax flavescens dwighti van Rossem

1 ♂, July 31; 1 ♀, Aug. 13.

One bird was taken in the pines, where it was to be expected, but the other was in the dense broadleaf forest. No more were seen. The weight of the male was 12.4 and that of the female 12.2 grams.

Myiobius barbatus sulphureipygius (Sclater)

1 ♂, July 29; 1 ♀, 1 ?, July 31; 1 ♂, Aug. 4; 2 ♀, Aug. 8; 1 ♂, 1 ?, Aug. 10; 1 ♂, Aug. 13; 1 ♂, Aug. 14; 1 ?, Aug. 16.

The species was a conspicuous constituent of the *selva*. Five males ranged in weight from 12.5 to 13.3 grams, with a mean of 12.92±0.15 grams. Three females weighed 9.1, 9.9, and 10.4 grams.

Onychorhynchus coronatus mexicanus (Sclater)

1 ♂, Aug. 17.

The specimen was the only individual observed. It weighed 21.4 grams.

PLATYRINCHUS MYSTACEUS CANCROMINUS Selater and Salvin

1 ♂, July 21; 1 ♂, July 24; 2 ♂, 1 ♀, 1 ?, July 27; 1 ♂, 1 ♀, 1 ?, July 31; 1 ♂, Aug. 9; 1 ♀, Aug. 13.

Some of the birds show a reduction in the streaking on the abdomen, indicating an approach toward *P. m. timothei,* but they are very richly colored, have breast bands, etc. — characters of *P. m. cancrominus.* They frequented the underbrush of the broadleaf forest in considerable numbers.

The weights of the males ranged from 10.0 to 12.0 grams, with a mean of 11.16±0.30. Females weighed 8.7, 9.7, 9.9 and 10.2 grams; two of indeterminate sex 9.3 and 13.0 grams.

RHYNCHOCYCLUS BREVIROSTRIS BREVIROSTRIS (Cabanis)

1 ♂, July 26; 2 ♂, July 31; 1 ♂ Aug. 5; 1 ♀, Aug. 8.

Rather an uncommon resident of the broadleaf forest. The males weighed 22.3, 23.1, 23.8, and 24.1 grams; a female 23.8 grams.

ONCOSTOMA CINEREIGULARE CINEREIGULARE (Sclater)

1 ♂, July 25; 1 ♀, Aug. 8; 1 ♂, Aug. 12.

These birds are slightly heavier than a series from the Yucatán Peninsula. The males weighed 7.6 and 7.8 grams; the female 7.4 grams. Peninsular males ranged from 5.2 to 6.7 grams, with a mean of 5.96±.18 grams and two females 5.0 and 5.6 grams. The species was scarce.

LEPTOPOGON AMAUROCEPHALUS PILEATUS Cabanis

1 ?, July 24.

This bird, the only example of the species which was seen, was in the heavy forest. It weighed 12.7 grams. Tashian (1952) recorded a female weighing 15.2 grams and Van Tyne (1935) a male weighing 10.8 grams.

PIPROMORPHA OLEAGINEA ASSIMILIS (Sclater)

1 ♀, July 22; 1 ♀, July 23; 1 ?, July 24; 1 ♂, July 27; 2 ♀, July 28; 1 ♂, July 29; 1 ♂, Aug. 18.

The most abundant of the Tyrannidae, and possibly of any

family. It was ubiquitous in the broadleaf forest and was found in lesser numbers in the *monte*. Although lacking in the pines, it was a regular visitor to an isolated fruiting tree (*Clusia* sp.) at the camp. Males weghed 12.7, 13.7, and 14.1 grams; females 12.2, 12.8, 14.8, and 15.2 grams.

Xanthoura yncas vivida Ridgway

1 ♀, July 21; 1 ♂, Aug. 2; 1 ♂, 1 ♀, Aug. 5; 1 ♀, Aug. 9; 1 ♀, Aug. 12; 1 ♀, Aug. 17.

These specimens are intermediate between *X. y. centralis* and *X. y. vivida*. They are nearer to the latter in that ventrally all are well washed with green, but few are as green as typical *X. y. vivida*. In size they fall within, or above, the upper half of the range for *X. y. centralis*, as given by Paynter (1955). All the specimens are worn or in molt; it is possible that in fresh plumage there would be less overlap with *X. y. centralis*.

Two males weighed 72.1 and 87.1 grams; five females from 84.0 to 88.0 grams, with a mean of 86.08±0.68.

Jays occurred commonly in the *selva*. They were present, but less abundant, in the pines and *monte*.

Thryothorus maculipectus umbrinus Ridgway

1 ♂, 1 ♀, July 22; 1 ♀, July 28; 1 ♀, July 29; 1 ♂, July 30; 1 ♂, Aug. 3; 1 ♂, Aug. 4; 1 ♂, 1 ♀, Aug. 8; 1 ♂, Aug. 11; 1 ♀, Aug. 13; 1 ♀, Aug. 15; 1 ♀, Aug. 18.

It is probable that *T. m. umbrinus* and *T. m. canobrunneus* may be distinguishable by a difference in weight. At Laguna Ocotal, six males ranged from 16.0 to 18.7 grams, with a mean of 16.76±0.47; five females from 13.4 to 15.4 grams, with a mean of 14.44±0.46. On the Yucatán Peninsula (Paynter, 1955), seven males ranged from 13.3 to 15.0 grams, with a mean of 14.36±0.77; 11 females from 11.9 to 12.8 grams, with a mean of 11.90±0.95.

These wrens ranged through the low forest in abundance. Occasionally they were found in the high broadleaf forest and in the brush at the edge of the pine zone.

Troglodytes musculus intermedius Cabanis

1 ♂, July 23; 1 ♂, Aug. 2; 1 ♀, Aug. 3; 1 ♂, Aug. 17.

In the scrubby pine burn the species was common, but it was one of the most difficult birds to collect because of its excessively shy nature.

At Ocosingo, where one specimen (male ?) was collected on July 8, and at El Real, where a female and male were taken on July 13 and 14, the species lived in the vicinity of houses and behaved like its northern counterpart, *T. aëdon*.

The weights of the males were 11.1, 11.2, 11.4, and 12.0 grams; those of the females 10.6 and 10.6 grams.

Henicorhina leucosticta prostheleuca (Sclater)

1 ?, July 22; 1 ♀, July 23; 1 ♀ ?, July 24; 1 ♂, 1 ?, July 25; 1 ♂, July 27; 1 ♂, July 30; 1 ♀, Aug. 1; 1 ♂, 1 ♀, Aug. 2; 1 ♀, Aug. 5; 1 ♂, Aug. 6; 1 ♂, Aug. 8; 1 ♂, Aug. 14; 1 ♂, Aug. 18.

A very abundant resident of the undergrowth in the broadleaf forest.

Seven adult males weighed between 14.4 and 17.3 grams, with a mean of 15.81±.32; five females from 14.1 to 16.7 grams, with a mean of 15.40±.41.

Henicorhina leucophrys castanea Ridgway

1 ♀, July 25; 1 ♂, Aug. 2.

These specimens apparently represent the first record of *H. l. castanea* from Mexico, although Hellmayr (1934) had predicted that it would be found there on the Atlantic slope. The respective weights of the male and female were 16.6 and 16.1 grams.

H. leucophrys and *H. leucosticta* were found in what seemed to be exactly the same habitat. No behavioral differences were noted. The darker breast of *H. leucophrys* could not be recognized in the dark undergrowth, making it impossible to distinguish between the two species. They were, therefore, collected at random. Presumably the ratio between the species in the collection also represents the true ratio at Laguna Ocotal.

Microcerculus marginatus philomela (Salvin)

1 ♀, July 26; 1 ♂, Aug. 9.

There is no doubt that this wren was uncommon but it was by no means rare, as the dearth of specimens would seem to indicate. Its call is distinctive and was heard about once a day while collecting in the broadleaf forest. It was seldom seen because of its preference for the darkest areas of the forest floor, where it blended ideally with the background.

The male weighed 18.1 grams; the unsexed bird 18.4 grams.

Turdus albicollis leucauchen Sclater

1 ♀, July 28; 1 ♂, Aug. 14.

The male retains the juvenal plumage on its throat, upper breast, wing coverts, neck, and pileum. The remainder of the plumage is slaty with a faint wash of olive. The other bird, an adult female, is decidedly olivaceous dorsally; the throat markings are brownish black. It agrees with specimens of *T. a. leucauchen* from Guatemala.

The weight of the male was 66.7 grams; that of the female 70.3 grams.

Myadestes unicolor pallens Miller and Griscom

1 ♂, July 31; 1 ♂, Aug. 1; 1 ♀, Aug. 7; 2 ♀, Aug. 11; 1 ♀, Aug. 12; 1 ♂, Aug. 15; 1 ♂, Aug. 18.

The type of *M. u. veraepacis,* 56 specimens of *M. u. pallens* from Honduras and Nicaragua, one specimen from Veracruz and three from "Mexico" of *M. u. unicolor,* and the present series from Chiapas have been examined. It is concluded that *M. u. pallens* is barely distinguishable from the nominate form, on the basis of its paler ventral color, and that *M. u. veraepacis,* which was described as an intermediate form, is referable to *M. u. pallens.* The supposed differences in size between the forms cannot be confirmed with the present material.

Because this is a montane species, it is presumed that the population north of the Isthmus of Tehuantepec has no contact with that which occurs from Chiapas southward. It is, therefore, not surprising that the series from Laguna Ocotal is referred to the more southern population, *M. u. pallens.* It

is strange, however, that the species does not subspeciate more markedly, since it is a member of a genus whose species are rather plastic.

Adult males weighed 34.1 and 38.2 grams; an adult female 36.1 grams; two males and a female which were in almost complete adult plumage 39.5, 40.7, and 36.3 grams, respectively.

Catharus mexicanus cantator Griscom

1 ♂, 1 ♀, July 25; 1 ♂, July 30; 1 ♀, Aug. 5; 1 ♀, Aug. 12; 1 ♀, Aug. 15.

Berlioz (1939) recorded the species from Chiapas for the first time, but lacking comparative material was unable to assign his series to a race.

The beautiful song of this thrush was often heard in the late afternoon and sometimes in the morning. It must have been fairly abundant, but it was very difficult to approach. Had it not been for the song, it would have been assumed to be a rare species. It was collected in the darkest parts of the broadleaf forest.

A young, spotted female weighed 29.0 grams; two females which were not quite adult 31.9 and 32.6 grams; two adult males and an adult female 33.1, 37.5, and 32.6 grams, respectively.

Smaragdolanius pulchellus pulchellus (Sclater and Salvin)

1 ♀, Aug. 3; 1 ♂, Aug. 12; 1 ♀, Aug. 13.

Alvarez del Toro (1952) has recorded this species in Chiapas, apparently for the first time. Blake (1953) also lists the bird from there but has informed me (*in litt.*), that his citation of the race *S. p. verticalis* from Chiapas is a *lapsus*.

Being a species which ranges in the tops of trees it is difficult to judge its abundance. It seemed to be uncommon. The male weighed 25.3 grams; the females 24.3 and 26.2 grams.

Hylophilus ochraceiceps ochraceiceps Sclater

1 ♂, 1 ♀, July 25; 1 ♂, July 27; 1 ♂, Aug. 1; 1 ♀, Aug. 12.

Prior to Alvarez del Toro's book (1952) the species does not seem to have been noted from Chiapas. It was common at Laguna Ocotal in the broadleaf forest.

Males weighed 11.1, 11.4, and 11.5 grams; females 10.5 and 10.8 grams.

Mniotilta varia (Linnaeus)

1 ♀, Aug. 12; 1 ♀, Aug. 15.

Black and White Warblers were first seen on August 11. The birds weighed 10.7 and 10.8 grams.

Parula americana inornata Baird

1 ♀, Aug. 12.

Parula "pitiayumi" appears to be only a morphologically pronounced subspecies group of *P. americana*. Unless sympatry can be shown to exist, the logical course seems to be to treat the groups as conspecific.

A pair of the warblers was in a flowering tree in the *monte* on August 12. No others were seen while at the lake.

The specimen weighed 6.9 grams, as did a female collected at Ocosingo on July 7.

Dendroica graciae decora Ridgway

1 ♀, July 22; 1 ♂, July 30; 1 ?, Aug. 18; 2 ♂, Aug. 19.

The species was abundant in the tops of the pines. It was noted in the broadleaf forest a few times.

The specimens exhibit no approach toward *D. g. ornata*, a distinctive form, which has been found in western Chiapas (e.g., Edwards and Lea, 1955) but for which there seems to be no published report in eastern Chiapas. In the Museum of Comparative Zoology there are, however, specimens referable to this race from Santa Rosa (Escuintla) and Nuevo Amatenango, localities near the Guatemalan border.

The respective weights of three males and a female were 7.3, 8.5, 8.7 and 7.6 grams. One bird was host to the hippoboscid *Ornithoctona fusciventris*.

Seiurus motacilla (Vieillot)

1 ♂, July 25; 1 ♀, Aug. 2; 1 ♂, Aug. 13.

After the first of August, Louisiana Waterthrushes were seen

at the rate of about one per day. The specimen collected on July 25 is a very early arrival, but at Palenque in 1949 Tashian (1952) observed the species on July 12.

The male weighed 18.4 grams; the females 16.7 and 18.9 grams.

Granatellus sallaei sallaei (Bonaparte)

1 ♀ ?, Aug. 10; 1 ♂, Aug. 13.

A rare inhabitant of the low forest at the end of the lake. The male weighed 14.0 grams, suggesting that this race is heavier than *G. s. boucardi*, six males of which are known to have ranged from 9.2 to 10.6 grams, with a mean of 10.00±.22 (Paynter, 1955). The bird whose sex could not be determined with certainty weighed 11.6 grams.

I have examined the type of *G. s. griscomi* van Rossem, a male, and find, as the describer claimed (1934), that dorsally it is less slaty and gray than most specimens of the species. The supposed differences in the distribution and shade of the red of the underparts, and of the gray on the throat, cannot be recognized by me.

The bird was received, as a mount, by the Museum of Comparative Zoology in 1880. It is presumed to have been collected at least a few years earlier. It was, therefore, well over fifty years old, at a minimum, when named as the type. It is soiled and has the oily texture that is often noticed in specimens which have been mounted and on display for many years. The characters ascribed to the race are without doubt functions of age and dirt. This belief is strengthened when old and fresh specimens of *G. s. boucardi*, or of *G. s. sallaei*, are compared. The older specimens are often noticeably darker.

Myioborus miniatus intermedius (Hartlaub)

1 ♂, July 26; 1 ♂, July 27; 1 ♂, July 31; 1 ♀, Aug. 3; 1 ♂, Aug. 13; 1 ♂, Aug. 14; 1 ♂, Aug. 16; 1 ♂, 2 ♀, Aug. 17; 1 ♂, Aug. 18; 2 ♂, Aug. 19.

The redstart was abundant in the *selva*. Two females weighed 9.0 and 9.1 grams; ten males ranged from 8.2 to 9.6 grams, with a mean of 8.86±0.14.

Basileuterus culicivorus culicivorus (Lichtenstein)

1 ♂, 1 ♀, July 22; 1 ♀, July 23; 1 ♀, 1 ?, July 24; 1 ♀, July 25; 1 ♂, July 26.

These were among the most abundant birds at the lake. They occurred in all types of habitat, with the exception of the pines, although they were most often found in the higher broadleaf forest.

Females weighed 8.8, 10.0, 10.3, and 10.4 grams; two males 9.8 grams each.

Basileuterus rufifrons salvini (Cherrie)

1 ?, July 14; 1 ♀, July 20; 1 ♂, July 23; 1 ♂, 1 ♀, Aug. 12.

This species replaced *B. culicivorus* in the pines, where it was common but usually too high to collect. Two males weighed 11.4 and 11.8 grams; two females 10.3 and 10.8 grams.

Todd (1929) and Griscom (1932) to the contrary, it appears that Ridgway (1902) was correct in treating *delattrii*, *salvini*, and *rufifrons* as conspecific. Griscom (1932) chose to regard each as a distinct species, claiming that all three forms are sympatric in the western cordillera of Guatemala, and that *salvini* and *rufifrons* are sympatric in Vera Paz. However, it is significant to note that one or another of these forms has been collected at approximately twenty localities in Guatemala (*vide* Griscom, 1932, and Todd, 1929, for lists), but at no given place has more than a single form been taken. Even when two collectors' stations are adjacent, there seems always to be a difference in their altitudes. Thus sympatry does not appear to exist. No intergradation between *B. r. delattrii* and either *B. r. rufifrons* or *B. r. salvini* is known but this may be of little significance since even in the comparatively well-studied region of Veracruz integration between *B. r. rufifrons* and *B. r. salvini* was undetected until 1943 (Wetmore).

Coereba flaveola mexicana (Sclater)

1 ♂, July 28; 1 ♀, Aug. 11; 1 ♂, Aug. 16.

Bananquits were rare and found only in the *monte*.

A mature male and female weighed 10.0 and 8.7 grams, respectively. An immature male 10.7 grams. The adult male had

fully enlarged testes. It was one of the few species exhibiting sexual activity at this season.

Amblycercus holosericeus holosericeus (W. Deppe)

1 ♂, Aug. 11.

This bird, which weighed 67.0 grams, was found in a dense tangle of vines near the shore of the lake. No more were seen.

Icterus mesomelas mesomelas (Wagler)

1 ♂, July 27; 1 ♀, Aug. 12.

The male weighed 42.7 grams; the female 35.0 grams. *Ornithoctona fusciventris* was found on the latter.

The dearth of clearings meant that habitats for most of the Icteridae were lacking. The almost total absence of orioles was one of the impressive ornithological features of the Laguna Ocotal region.

An oropendola was seen in the forest by one of the party, but whether it was *Zarhynchus wagleri* or *Gymnostinops montezuma* is unknown.

Tanagra lauta lauta Bangs and Penard

1 ♂, Aug. 2; 1 ♀, Aug. 4; 1 ♂, Aug. 17.

One bird was taken in the pines and the others in the low forest. The species was rather uncommon.

The male collected August 2 had slightly enlarged gonads; that taken August 17 retained about half of its juvenal plumage but had fully enlarged testes. Breeding in transitional plumage has been reported before (e.g., Skutch, 1954).

The first male weighed 14.8 and the second 16.4 grams; the female 17.6 grams.

Tanagra gouldi gouldi (Selater)

1 ♀, July 21; 1 ♂, July 23; 1 ♀, July 26; 1 ♂, 1 ♀, July 31; 1 ♀, Aug. 4; 1 ♂, Aug. 5; 1 ♀, Aug. 6; 1 ♂, Aug. 14; 1 ♂, Aug. 16; 1 ♂, Aug. 18.

These were the most abundant of the tanagers, ranging through the broadleaf forest to the edge of the pines.

Six males had a mean weight of 13.73±0.11 grams, with a

range from 12.7 to 14.5. The mean of five females was 14.00± 0.47 grams and their range 12.9 to 15.3.

Tangara nigrocincta larvata (Du Bus)

1 ♂, 1 ?, July 28; 1 ♀, Aug. 6; 1 ♂, Aug. 12; 1 ♀, Aug. 13; 1 ♀, Aug. 18.

The specimens were taken in either the *monte* or the *Clusia* tree at our camp.

Males weighed 18.6 and 19.7 grams; females 20.2, 20.3, and 21.9 grams.

Thraupis abbas (W. Deppe)

1 ♀, July 25; 1 ♀, July 28; ♀, Aug. 1; 1 ♀, Aug. 9; 1 ♂, Aug. 13.

The species was seldom noted in the tropical evergreen forest, but was very abundant in the pines, frequently moving through the tops of the trees in flocks of about ten individuals.

A male weighed 46.2 grams; females 40.3, 46.2, 47.4, and 48.4 grams.

Philogothraupis sanguinolenta sanguinolenta (Lesson)

1 ♂, July 25; 1 ♂, July 26; 1 ♂, Aug. 12; 1 ?, Aug. 13.

The weights of the males were 38.8, 40.0, and 44.2 grams.

The species was moderately common but more shy than most tanagers. It came to exposed areas at times but generally was present in the heavier *selva*.

Piranga leucoptera leucoptera (Trudeau)

1 ?, July 22; 1 ♂, Aug. 4; 1 ♂, Aug. 11; 1 ♀ ?, Aug. 16; 2 ♂, Aug. 18.

Usually these birds were found in small flocks along the edges of trails and in the *monte*.

The mean weight of five males was 16.68±.32. They ranged from 15.5 to 17.4 grams.

One specimen harbored the bird-fly *Ornithoctona fusciventris*.

Habia rubica rubicoïdes (Lafresnaye)

1 ♀, July 22; 1 ♂, July 23; 1 ♀, July 24; 1 ♀, July 30; 1 ♂, 2 ♀, July 31; 1 ♂, Aug. 8; 1 ♀, Aug. 11; 1 ♂, Aug. 16; 1 ♂, Aug. 17; 3 ♂, Aug. 18.

This form was more common than *H. gutturalis*. Both species occurred throughout the broadleaf forest, with occasional appearances in the *monte*. There was no noticeable difference in habitat preference between the two forms.

These specimens lend credence to the suggestion (Paynter, 1955) that *H. r. nelsoni* may weigh less than *H. r. rubicoïdes*, although this still cannot be proved. Six adult male *H. r. rubicoïdes* ranged from 35.8 to 40.5 grams, with a mean of 38.00±.71; five adult females from 27.8 to 33.6 grams, with a mean of 31.04±1.07. Adult males of typical *H. r. nelsoni* were reported (Paynter, 1955) to weigh 27.7, 30.4, 31.5, and 32.1 grams; a female 27.5 grams.

Habia gutturalis salvini (Berlepsch)

1 ♀, July 23; 1 ♂, July 24; 1 ♂, July 27; 1 ♂, July 30.

The unsexed specimen weighed 42.9 grams; the remaining birds all of which are immature, 42.7, 43.6, and 43.7 grams.

This series is unsatisfactory for subspecific determination. It seems, however, to be more similar to immature specimens from the range of *H. g. salvini* than to the limited material I have seen of immature *H. g. littoralis*, a weak or possibly invalid, race.

Chlorospingus ophthalmicus dwighti Underdown

1 ♂, 1 ♀, July 21; 1 ♂, 1 ♀, July 22; 2 ♂, 1 ♀, July 23; 1 ♂, 1 ♀, July 24; 1 ♂, Aug. 1; 1 ♂, Aug. 2; 1 ♀, Aug. 7; 1 ♀, Aug. 10.

Along the edges of trails and within the broadleaf forest, wherever there was low vegetation, these birds swarmed.

Adult males weighed 18.6, 18.7, and 19.7 grams; females 17.2 and 17.4 grams. Juvenal males weighed 18.6, 18.6, 18.7, and 18.8 grams; females 16.0 and 17.3 grams.

Chlorophanes spiza guatemalensis Sclater

1 ♀, July 31.

Only this bird was seen. It weighed 22.1 grams and was fatty.

Cyanerpes cyaneus carneipes (Sclater)

1 ♂, July 20; 1 ♂, July 24; 1 ♂, July 25; 1 ♂, July 30; 1 ♀, Aug. 18.

The species was most often seen in the *Clusia* tree at the camp.

Adult males weighed 13.1 and 13.3 grams; an immature male 12.2 grams; females 12.3 and 13.4 grams.

Saltator atriceps atriceps (Lesson)

1 ♂, Aug. 9; 1 ♀, Aug. 10.

The gonads of the male were very enlarged and that of the female moderately enlarged.

None of the saltators was common, but this was the most frequently observed of the three. All the forms frequented the brush where the broadleaf and pine forests joined.

The weights of the male and female were 77.3 and 85.5 grams, respectively.

Saltator maximus gigantoides Cabanis

1 ♀, Aug. 3; 1 ♂, Aug. 12.

These specimens have only a trace of green on the pelium, leaving no doubt that they are referable to this race rather than to *S. m. magnoides,* which has been recorded from near Comitán (Berlioz, 1939).

The male, which had enlarged testes, weighed 52.3 grams. The female, whose ovary was slightly enlarged, weighed 48.4 grams.

Saltator coerulescens yucatenensis Berlepsch

1 ♂, July 27.

To find this race at Laguna Ocotal was unexpected, but the specimen is pale, has only a faint wash of buffy on the breast, and has a light crissum, all characters differentiating *S. c. yucatenensis* from *S. c. grandis.* Although it may be an aberrant bird, additional specimens from the region will probably confirm the identification, inasmuch as Brodkorb (1943) found a series from eastern Tabasco to be closer to *S. c. yucatenensis* than to *S. c. grandis.*

The bird, which was reproductively active, weighed 54.2 grams.

Caryothraustes poliogaster poliogaster (Du Bus)

1 ♂, 1 ♀, Aug. 10; 1 ♀, Aug. 18.

Flocks of these birds were seen regularly in one area of transi-

tion between the *selva* and *ocotal,* where the vegetation was fairly high but not dense. They were seldom seen elsewhere.

The male weighed 48.6 grams; the females 49.3 and 50.7 grams.

Cyanocompsa cyanoides concreta (Du Bus)

1 ♂, July 27; 1 ♀, July 31; 1 ♂, Aug. 14; 1 ♂, Aug. 19.

The male taken July 27 had enlarged testes. That collected on August 14, an immature bird, was host to *Ornithoctona fusciventris.*

Adult males weighed 30.5 and 30.9 grams; an immature male 27.6 grams; an adult female 30.4 grams.

Sporophila torqueola morelleti (Bonaparte)

1 ♂, July 26; 1 ♂, Aug. 8; 1 ♂, Aug. 13.

In the vicinity of the marsh near the campsite, seedeaters were seen and heard daily. A few were also found in the pine burn, but none elsewhere.

The bird taken on August 13, which is immature, weighed 8.7 grams. The remaining birds were in full breeding condition and weighed 8.9 and 9.6 grams.

Oryzoborus funereus Selater

1 ♂, 1 ♀, Aug. 2.

The birds, both of which had fully enlarged gonads, were collected in the pine burn. The area was searched for additional birds, but this pair was the only one found. The species was reported from Chiapas once before (Brodkorb, 1943).

The weights of the male and female were 14.3 and 14.7 grams, respectively.

Atlapetes albinucha (Lafresnaye and d'Orbigny)

1 ♂, July 30; 1 ♂, Aug. 3.

The August 3 specimen is a fledgling, which was barely able to fly; the other a juvenal. Both birds were taken in the underbrush of the pine burn. Only one other was seen during the month at the site.

The fledgling weighed 32.5 and the juvenal 33.2 grams.

DISCUSSION

One hundred and twenty-two species of birds were collected or observed during the period spent at Laguna Ocotal. Of this number, 119 are presumed to breed in the vicinity and three are known to be visitors (*Empidonax minimus, Mniotilta varia,* and *Seiurus motacilla*).

The avifauna of the lowlands to the north and to the east of the Selva Lacandona is fairly well known, affording a useful basis for comparison with that which was found at Laguna Ocotal. Brodkorb (1943) has surveyed the birds of Tabasco and adjacent areas in Veracruz, Campeche, and Chiapas; Tashian's report (1952) on the birds of Palenque, Chiapas, is an informative supplement. To the east, the district of Petén, Guatemala, has been investigated by Van Tyne (1935) and Taibel (1955). The localities encompassed by these papers are situated at altitudes below 250 meters, with a few insignificant exceptions. A large part of the region is covered by "high evergreen forest," to use the terminology of Miranda (1952). However, the composition of the forest differs from that at Laguna Ocotal and is the type commonly called "rain forest." The distinction between the high evergreen forest at Laguna Ocotal and that which is found at lower altitudes is considered in the paper introducing this series pp. 193-199).

The birds in the highlands contiguous with the Selva Lacandona are not so well known. Berlioz's (1939) report on a collection from the district of Comitán is the nearest approach to a detailed study, but it seems that the collector (Mario del Toro Avilés) was selective and did not attempt to obtain representatives of all the species in the region. The paucity of raptorial and aquatic species is particularly noticeable. The collector spent a few days, in April and October, at Comitán (alt. 1650 m.), a sizable town on a plain, with oak and coniferous forests a short distance away. He collected for 20 days in August and for four days in October at Juncana (alt. 1645 m.), a village situated in the oaks and pines, 40 kilometers southeast of Comitán. From May to August he worked at Santa Rosa, which, Prof. Brodkorb (*in litt.*) informs me, is a finca, at an altitude of about 1200 meters, near the Guatemala border and east of Laguna Montebello, roughly seventy kilometers southeast of

Comitán. According to Prof. Brodkorb, this region is characterized by high rainfall and by the presence of the Sweet Gum (*Liquidambar styraciflua*). Miranda (1952) maps the area within the zone of "temperate deciduous woods," one of whose key species is *Liquidambar*.

When the resident birds at Laguna Ocotal are compared with those known from adjacent Veracruz, Tabasco, Chiapas, Campeche, and Petén (Brodkorb, 1943; Tashian, 1952; Van Tyne, 1935; Taibel, 1955), it is seen (Table 1, p. 284) that 24 of the 119 species (22 per cent) have not been found in the lowlands encompassed by these studies. Of these 24 birds, four (*Spizaëtus tyrannus, Micrastur semitorquatus, M. ruficollis,* and *Chlorophanes spiza*) are uncommon species which have been collected at low altitudes nearby, e.g., on the Yucatán Peninsula (Paynter, 1955), and in time probably will be found in the regions under consideration. The 20 species remaining are characteristic of higher elevations, with none having been found below roughly 300 meters, at least in northern Middle America.

With the exception of the pines, the vegetation at Laguna Ocotal is physiognomically similar to that of the lowlands. Therefore, the presence of the conifers might logically seem to be the cause of the difference in composition of the two avifaunas. However, this is not the case. Only four species are confined to the pines at Laguna Ocotal. These are *Lepidocolaptes souleyetii, L. affinis, Contopus pertinax,* and *Basileuterus rufifrons; Dendroica graciae* was abundant in the pines but was seen in the broadleaf forest on a few occasions. Of these five species, only *Lepidocolaptes affinis* and *Dendroica graciae* do not occur in the adjacent lowlands. More subtle differences in the environments must be responsible for the discrepancy between the avifaunas of the two regions.

If the resident birds of Laguna Ocotal are compared with those listed by Berlioz (1939) for the District of Comitán, Chiapas (2100 to 1650 m.), it is seen (Table 2, p. 285) that 54 species (45 per cent) have not been recorded at the higher elevations. Owing to what certainly was discriminating collecting in the highlands (e.g., *Cathartes aura* is not recorded), the difference between the two avifaunas is doubtless exaggerated, but still it must be substantial. Most of the species in Table 2 are forms which frequent lower altitudes and would be unexpected in the District

of Comitán. It is interesting to note that of the 24 birds listed in Table 1 as not occurring in the nearby lowlands, 18 are recorded in the highlands (Berlioz, 1939), including the so-called "lowland forms" *Micrastur ruficollis* and *Chlorophanes spiza*.

From this it may be concluded that the composition of the avifauna of Laguna Ocotal is intermediate between that of the adjacent lowlands and highlands, with a stronger element from the lowlands. The presence of pines at Laguna Ocotal, the one strikingly marked vegetational difference between the lowlands and the lake district, has almost no effect on the composition of the avifauna.

LITERATURE CITED

Alvarez del Toro, Miguel
1952. Los Animales Silvestres de Chiapas, Tuxtla-Gutiérrez, Chiapas, Dept. de Prensa y Turismo, 247 pp.

Amadon, Dean
1949. Notes on *Harpyhaliaetus*. Auk, **66:** 53-56.

——— and Don R. Eckelberry
1955. Observations on Mexican Birds. Condor, **57:** 65-80.

Berlioz, J.
1939. Étude d'une Collection d'Oiseaux du Chiapas (Mexique). Bull. Mus. Nat. Hist. Natur. (Paris), (2), **11:** 360-377.
1952. Étude Critique des Formes de *Momotus momota* (L.). Oiseau, **22:** 20-33.

Blake, E. R.
1953. Birds of Mexico; a Guide for Field Identification. Chicago. Univ. Chicago Press. xxix + 644 pp.

Brodkorb, Pierce
1943. Birds from the Gulf Lowlands of Southern Mexico. Univ. Mich., Mus. Zool., Misc. Pub., No. 55, 88 pp.

Edwards, E. P. and R. B. Lea
1955. Birds of the Monserrate Area, Chiapas, Mexico. Condor, **57:** 31-54.

FRIEDMANN, HERBERT, LUDLOW GRISCOM, and R. T. MOORE
1950. Distributional Check-list of the Birds of Mexico, Part I. Berkeley, Calif. Cooper Ornithological Club, Pacific Coast Avifauna, No. 29. 202 pp.

GRISCOM, LUDLOW
1932. The Distribution of Bird-life in Guatemala. Bull. Am. Mus. Nat. Hist., **64**, vi + 439 pp.

HELLMAYR, C. E.
1934. Catalogue of Birds of the Americas and Adjacent Islands. Field Mus. Nat. Hist., Pub. 330, Zool. Ser., **13** (7), vi + 531 pp.

MARTIN, P. S., C. R. ROBINS, and W. B. HEED
1954. Birds and Biogeography of the Sierra de Tamaulipas, an Isolated Pine-Oak Habitat. Wilson Bull., **66**: 38-57.

MIRANDA, FAUSTINO
1952. La Vegetación de Chiapas, Parte I. Tuxtla-Gutiérrez, Chiapas, Dept. de Prensa y Turismo. 334 pp.

PAYNTER, R. A., JR.
1955. The Ornithogeography of the Yucatán Peninsula. Bull. Peabody Mus. Nat. Hist., Yale Univ., **9**: 1-347.

PETERS, J. L.
1948. Check-list of Birds of the World. Vol. 6. Cambridge, Mass. Harvard Univ. Press. xi + 259 pp.

RIDGWAY, ROBERT
1902. Birds of North and Middle America. Bull. U. S. Nat. Mus., **50** (2), xx + 834 pp.

SKUTCH, A. F.
1954. Life Histories of Central American Birds, Berkeley, Calif. Cooper Ornithological Soc., Pacific Coast Avifauna, No. 31. 448 pp.

TAIBEL, A. M.
1955. Uccelli del Guatemala con Speciale Riguardo alla Regione del Petén Raccolti dal Maggio al Settembre 1932. Atti Soc. Ital. Sci. Nat., **94**: 15-84.

TASHIAN, R. E.
1952. Some Birds from the Palenque Region of Northeastern Chiapas, Mexico. Auk, **69:**, 60-66.

TODD, W. E. C.
1929. A Revision of the Wood-warbler Genus *Basileuterus* and its Allies. Proc. U. S. Nat. Mus., **74:** 1-95.

TRAYLOR, M. A., JR.
1941. Birds from the Yucatan Peninsula, Field Mus. Nat. Hist., Pub. 483, Zool. Ser., **24** (19) : 195-225.

VAN ROSSEM, A. J.
1934. Critical Notes on Middle American Birds. Bull. Mus. Comp. Zool., **77:** 387-490.

VAN TYNE, JOSSELYN
1935. The Birds of Northern Petén, Guatemala. Univ. Mich., Mus. Zool., Misc. Pubs. No. 27, 46 pp.

WETMORE, ALEXANDER
1927. The Birds of Porto Rico and the Virgin Islands. New York Acad. Sci., Sci. Surv. Porto Rico and Virgin Ids., **9:** 245-596.
1943. The Birds of Southern Veracruz, Mexico. Proc. U. S. Nat. Mus., **93:** 215-340.

TABLE 1

Species of birds found at Laguna Ocotal but not recorded from adjacent lowlands.

Accipiter striatus	*Myrmotherula schisticolor**
Spizaëtus tyrannus	*Empidonax flavescens**
Micrastur semitorquatus	*Microcerculus marginatus**
*Micrastur ruficollis**	*Myadestes unicolor**
*Abeillia abeillei**	*Catharus mexicanus**
Amazilia beryllina	*Smargdolanius pulchellus*
*Eupherusa eximia**	*Parula americana*
*Lampornis viridi-pallens**	*Dendroica graciae**
*Xiphorhynchus erythropygius**	*Myioborus miniatus**
*Lepidocolaptes affinis**	*Chlorospingus ophthalmicus**
*Anabacerthia striaticollis**	*Chlorophanes spiza**
*Sclerurus mexicanus**	*Atlapetes albinucha**

*Recorded from Comitán District (Berlioz, 1939).

TABLE 2

Species of birds found at Laguna Ocotal but not recorded from adjacent highlands.

Phalacrocorax brasilianus
Butorides virescens
Sarcoramphus papa
Cathartes aura
Elanoïdes forficatus
Accipiter striatus
Buteogallus urubitinga
Spizaëtus tyrannus
Herpetotheres cachinnans
Micrastur semitorquatus
Crax rubra
Penelope purpurascens
Ortalis vetula
Aramus guarauna
Aramides cajanea
Laterallus ruber
Columba nigrirostris
Ara macao
Amazilia candida
Amazilia beryllina
Trogon massena
Trogon violaceus
Chloroceryle aenea
Pteroglossus torquatus
Ramphastos sulfuratus
Centurus pucherani
Veniliornis fumigatus
Dendrocincla anabatina
Dendrocincla homochroa
Dendrocolaptes certhia
Lepidocolaptes souleyetii
Xenops minutus
Dysithamnus mentalis
Platypsaris aglaiae
Tyrannus melancholicus
Megarhynchus pitangua
Myiozetetes similis
Myiobius barbatus
Onychorhynchus coronatus
Leptopogon amaurocephalus
Xanthoura yncas
Henicorhina leucosticta
Smaragdolanius pulchellus
Hylophilus ochraceiceps
Parula americana
Granatellus sallaei
Icterus mesomelas
Tanagra lauta
Tanagra gouldi
Tangara nigrocincta
Habia gutturalis
Saltator coerulescens
Cyanocompsa cyanoides
Oryzoborus funereus

VIII

DESIGN QUANTITIES OF SOME CHIAPAS BIRDS

By

Charles H. Blake

What an airplane or a bird is capable of in the way of flight is largely deducible from a few rather simple ratios. Obviously, ability to perform as well as the design permits depends on an adequate power plant and a sufficiently strong and responsive control system. We do not yet know how to assess these latter properties in a bird, but the design quality of the wings can be discussed in general from the quantities here presented.

Three quantities are considered here: wing loading, span loading, and aspect ratio. These are derived from three measurements: weight, wing area, and wing span. English units are used to render comparison with airplanes easier.

The area is that of the slightly flattened wings. Ideally it should be the projected area of the wings fully outstretched in flight. This can only be closely approximated.

The span is twice the length of the wing beyond the edge of the body in the attitude in which the area is measured. This is less than the tip to tip distance or wing expanse.

Wing loading is expressed as pounds of weight per square foot of wing area. Similarly span loading is in pounds per foot of span.

The aspect ratio is dimensionless and most conveniently calculated as the square of the span divided by the wing area.

The wing loading is an indicator of the relative power required for acceleration. Takeoff and climbing are more difficult with higher wing loading. On the other hand, stability varies in the same sense as wing loading. Span loading is a measure of maneuverability. Birds with high span loadings will have difficulty in turning rapidly unless the aspect ratio is very low. The aspect ratio is related to lift. The higher the aspect ratio the greater the lift in proportion to the wing area. In general, birds with high aspect ratios glide and soar readily or remain in the air for long periods or both. It is also generally true that a high aspect ratio improves stability at low speeds. Similar effects

can be obtained by high wing camber or an appropriate dihedral angle between the wings.

I am greatly indebted to Raymond A. Paynter, Jr. for making (in the field) the outlines of the wings of 21 birds comprising 18 species, shown in the table, and recording the weights of the individuals drawn. The series is important because it gives us our first information on almost all the included families, and it is the first sizable series of sedentary species. I also thank the Geological Survey Department, Jamaica, B. W. I., for the use of a planimeter.

There is, of course, great risk in speaking definitely about the flight of species one has never seen alive. Some general remarks may be made on the basis of the quantities themselves. The wing loadings are very diverse. *Tinamus* has a loading that is high even for a bird weighing nearly 2½ pounds. By contrast, the specimen of *Ortalis* has less than one-third the weight but more than two-thirds the wing area of the *Tinamus*. One would readily believe that *Tinamus* would take off with difficulty and even reluctantly. It might, however, fly well on a straightaway after it was up to speed. This is a matter of motor rather than wings. If the motor is only sufficiently powerful to maintain cruising speed, then takeoff becomes virtually impossible. This is probably not quite true of any bird. With a high wing loading considerable excess power must be available. These remarks also apply, with less force, to the toucan, *Pteroglossus,* and the parrot, *Pionus*. If the figures for other parrots are similar to those for *Pionus*, their rather labored, although rapid, flight is understandable. At the other extreme are a hummingbird, *Abeillia*, and a woodhewer, *Sittasomus*, whose wing loadings are close to the lowest on record. Their flight should be about equally unstable but in other respects entirely different.

Turning to the span loadings, *Tinamus* is again unusual in its high loading. No other bird in the list exceeds 0.5 and span loadings above this latter figure are very rare. The two hummingbirds show the lowest loadings. It should be noted that *Eupherusa* has about twice the wing loading as well as about twice the span loading of *Abeillia*. It would be expected, *a priori,* that the flight of these two birds would be quite different. *Abeillia* ought to be the more maneuverable. It is possible that

the curious flitting flight occasionally shown by some of the larger hummingbirds, notably *Trochilus* and *Anthracothorax,* is connected with the very low loadings and high aspect ratios.

The aspect ratio shows clearly that only the hummingbirds would be likely to fly continuously for any length of time. But two other species in the list even attain a ratio of 5.0 and one of these is the parrot. These low ratios may well be characteristic of nearly non-migratory species. Generally the aspect ratio of North American passerines seems to be from 5.5 to 7. I have recently measured a specimen of *Coccyzus americanus,* migratory but not appearing to be a strong flyer, and found an aspect ratio of 5.9.

In this connection it is of more than incidental interest that one of Otto Lilienthal's later gliders had an aspect ratio of about 3½. Such a machine would have very low stability at low speeds and his control system was slow and cumbersome. It is no wonder that he met his death in a crash. On the other hand, a small bird has such low terminal velocity that the legs can take up the shock of a fall from almost any height. The bird gets into trouble by running into some barrier beak first in full flight or attempting to land while its forward speed is much in excess of stall speed.

In two cases, as shown, two individuals of the same sex were available. The derived ratios agree within 10 per cent; quite a reasonable agreement.

With a few exceptions, the general picture is one of low speed, short and unstable flight. It is probable that most of these birds do not venture out in the open where they might encounter both wind and turbulence.

TABLE 1
MEASUREMENTS AND QUANTITIES

FAMILY	NAME	WT.	AREA	SPAN	WING LOADING	SPAN LOADING	ASPECT RATIO
Tinamidae	*Tinamus major robustus* ♀	2.41	0.918	1.85	2.63	1.30	3.7
Cracidae	*Ortalis v. vetula* ♀	0.682	0.660	1.46	1.03	0.467	3.2
Psittacidae	*Pionus s. senilis* ♀	0.488	0.402	1.50	1.21	0.325	5.6
Alcedinidae	*Chloroceryle americana septentrionalis* ♀	0.090	0.134	0.75	0.67	0.120	4.2
Momotidae	*Hylomanes m. momotula* ♂ [1]	0.073	0.104	0.65	0.70	0.113	4.2
"	*Momotus momota lessoni* ♂	0.289	0.348	1.31	0.83	0.221	4.9
Rhamphastidae	*Pteroglossus t. torquatus* ♂	0.462	0.347	1.09	1.33	0.425	4.0
Trochilidae	*Eupherusa e. eximia* ♂	0.0095	0.017	0.38	0.56	0.025	8.5
"	*Abeillia a. abeillei* ♂ *imm.*	0.0066	0.025	0.46	0.24	0.014	8.5
Dendrocolaptidae	*Dendrocincla a. anabatina* ♂	0.082	0.152	0.81	0.54	0.101	4.3
"	*Sittasomus griseicapillus sylvioides* ♂	0.023	0.088	0.65	0.26	0.035	4.8
"	*Xiphorhynchus erythropygius parvus* ♂	0.095	0.194	0.85	0.49	0.112	3.7
"	*Xiphorhynchus erythropygius parvus* ♀	0.093	0.155	0.78	0.60	0.119	3.9
Furnariidae	*Anabacerthia striaticollis variegaticeps* ♂	0.052	0.084	0.56	0.62	0.093	3.7
"	*Automolus ochrolaemus cervinigularis* ♂ [1]	0.105	0.133	0.67	0.79	0.157	3.3
Formicariidae	*Grallaria g. guatimalensis* ♂	0.218	0.200	0.88	1.09	0.248	3.9
Cotingidae	*Tityra semifasciata personata* ♂	0.171	0.189	0.97	0.91	0.177	5.0
Pipridae	*Pipra m. mentalis* ♀	0.037	0.075	0.57	0.49	0.065	4.3
"	*Schiffornis turdinus verae-pacis* ♀	0.072	0.126	0.69	0.57	0.104	3.8

[1] Average of 2 specimens.

IX

MAMMALS COLLECTED AT LAGUNA OCOTAL

By

Frances L. Burnett and Charles P. Lyman

This collection was made at Laguna Ocotal, Chiapas, Mexico, between July 22 and August 19, 1954, by R. A. Paynter, Jr., and Elisha F. Lee. The specimens were all collected in the vicinity of the camp, and consist of skins and skulls, unless otherwise noted.

The mammals are for the most part lowland forms, with a few subspecies which are so widespread that they are found in the highlands as well. In subspecies with restricted ranges, the races from Laguna Ocotal are in general similar to those collected by Kuns and Tashian (1954) from Palenque to the northwest, while Murie's (1935) collection from Uaxactún, Petén, Guatemala, to the northeast contains more species endemic to the Yucatán Peninsula. Of the mammals which tend to be restricted to the Yucatán Peninsula, the fruit bat *Artibeus jamaicensis yucatanicus* is the only race represented in the collection from Laguna Ocotal.

We wish to thank Dr. Charles O. Handley, Jr., of the United States National Museum for comparing our spider monkey with material in the United States National Museum. Also we gratefully acknowledge the loan of comparative material from the following institutions: Museum of Zoology, Ann Arbor, Michigan; American Museum of Natural History, New York City; Fish and Wildlife Service, United States Department of the Interior, Washington, D.C.; Chicago Museum of Natural History, Chicago, Illinois; and Museum of Natural History, Lawrence, Kansas. In particular, we thank Miss Barbara Lawrence for her help in preparation of the manuscript.

Didelphis marsupialis ?subsp.

1 ♂, 2 ♀ ♀ (M.C.Z. 47274-47276)

These young opossums are relatively too large to be *yucatanensis* and could be assigned to *tabascensis* on geographic

grounds. One difference between the latter subspecies and *mesamericana* (=*marsupialis* Allen, 1901) was said to be the greater length of tail compared to head and body. Using Allen's tables it is found that the average of the individual ratios of tail length to head and body length for 42 *mesamericana* is 89.8 (expressed in per cent) with a standard deviation of ±7.5 while the ratio for 21 *tabascensis* is 91.9 with a standard deviation of ±11.5. Obviously this difference has no statistical value. The Laguna Ocotal specimens have ratios of tail length to head and body length of 84, 88 and 91.

Long nasals, terminating posteriorly in a sharp point, were also used to characterize *tabascensis*. However, in four specimens in the M.C.Z. collection, all taken within a few days in the vicinity of Córdoba, Veracruz, one (M.C.Z. 39772) has nasals which come to a sharp point in the midline, while the posterior portion of the nasals of another (M.C.Z. 39770) are rounded in outline. The two others (M.C.Z. 39771 and 39767) have nasals which are intermediate between the extremes. There is no indication that the shape of the nasals is dependent on the age or the sex of the animals. As the length of the nasals depends partly on the shape of their posterior border, measurements of nasal length on skulls of the same size would then vary according to the outline.

Our evidence supports Hershkovitz's (1951) opinion that there is only one widespread form of *Didelphis marsupialis* in Mexico and in Central America north of the highlands of Nicaragua.

ARTIBEUS JAMAICENSIS YUCATANICUS J. A. Allen

4 ♂ ♂, 3 ♀ ♀ (M.C.Z. 47278-47284)

The measurements of these fruit bats correspond with those that Andersen (1908) gives for *yucatanicus* rather than those for the larger race, *jamaicensis*. Andersen did not group his results according to sex, but forearm length and various skull measurements of the Laguna Ocotal specimens indicate that the females tend to be smaller than the males. Our Chiapas skulls are smaller than *jamaicensis* skulls of the same sex from Veracruz, British Honduras, and Honduras.

Other scattered records indicate that this subspecies ranges into northern Guatemala (Murie, 1935) and northeastern Chiapas (Kuns and Tashian, 1954).

Alouatta palliata pigra Lawrence

2 ♂ ♂, 1 ♀ (M.C.Z. 47266-47268) Skins and skeletons

This series of howler monkeys was all collected in August from a band of five individuals. The skin of the female is typically black and in this resembles a male topotype from British Honduras collected in April. The males, on the other hand, have an extensive region between the shoulders, fading to a point in the middle of the back, where the bases of the hairs are pale. In addition, similarly colored hairs are interspersed among the darker hairs under the forearms of one of these skins. All have longer, denser hair than has the single topotype. The skulls of the males are even more massive than the topotype while that of the female is, as would be expected, considerably smaller.

The collection of these specimens extends the range of *pigra* 125 miles to the west and south of the type locality of Uaxactún, Guatemala. Kuns and Tashian (1954) report a specimen from Palenque, Chiapas as *mexicana*.

Ateles geoffroyi vellerosus Gray

1 ♀ (M.C.Z. 47269) Skin and skeleton

Dr. Charles O. Handley, Jr. very kindly identified this specimen of spider monkey as *vellerosus* through comparison with material in the United States National Museum. He writes that the Laguna Ocotal skin is very similar to one from Palenque in Chiapas, but somewhat darker and more richly colored than specimens from Oaxaca and Veracruz. No comparison was needed with *pan* from Guatemala, which is very much blacker, nor *yucatanensis* which is smaller and paler. This specimen was collected well within the range of this widespread subspecies (Kellogg and Goldman, 1944).

Paynter reports that there were fewer spider monkeys than howler monkeys at the lake. Small bands of three or four *Ateles* were seen every few days, while bands of howler monkeys could be heard around the camp almost every evening.

Sciurus deppei deppei Peters

5 ♂ ♂, 3 ♀ ♀ (M.C.Z. 47289-47296)

These small tree squirrels are as dark as typical *deppei* from

central Veracruz but are a little smaller when compared to the measurements given by Nelson (1899). Apparently the northeasterly extent of the range of this subspecies runs approximately from the western side of Lago de Izabal (Goodwin, 1934) northwest through Laguna Ocotal to Palenque (Kuns and Tashian, 1954). To the northeast Murie (1935) found the brighter colored *vivax*. At Laguna Ocotal the habitat of this squirrel was restricted to the tropical evergreen forest.

Sciurus aureogaster aureogaster F. Cuvier

1 ♂, 2 ♀ ♀ (M.C.Z. 47286-47288)

The collection of fire-bellied squirrels at Laguna Ocotal extends the limits of their range more to the south and closer to the Guatemalan border, though Dr. Remington Kellogg and Dr. Charles O. Handley, Jr. write us that no specimen of *aureogaster* has yet been taken in Guatemala proper. In comparison with more northern specimens no noticeable differences in the skulls could be found, but these Chiapas squirrels are not as dark in color. However, as Kelson (1952) has pointed out, *aureogaster* varies considerably in the degree of melanism in various areas of its range.

Paynter found these squirrels on the forest edges, amid thick tangles of small trees and vines, in contrast to the deep forest habitat of *deppei*.

Heteromys desmarestianus desmarestianus Gray

1 ♂, 1 ♀ skins and skeletons, 1 ♀ (M.C.Z. 47298-47300)

Laguna Ocotal is near the central point of the range of this widespread subspecies, and the specimens taken match Goldman's (1911) description.

Oryzomys couesi couesi (Alston)

30 ♂ ♂, 23 ♀ ♀, 1 ? sex (M.C.Z. 47331-47354, 47356-47385)

Fifty-one skins and skulls, as well as three skulls only, were collected of this larger rice rat. Most of these animals were quite young, ranging from sub-adults with the upper third molars just erupting to adults with slightly worn molars. The pelage of these animals is darker than that of specimens from Yaruca.

Honduras, which Goldman (1918) considered typical *couesi*. This darker cast is due to a more plumbeous color in the bases of the dorsal hairs, with the guard hairs being black instead of brownish. A detailed comparison of the skulls of these specimens with over 90 *couesi* of similar ages (as indicated by tooth wear) from other localities revealed no significant differences in the Laguna Ocotal specimens. Topotypical adults of *pinicola* from Pine Ridge, British Honduras, were smaller than mature but younger animals from Laguna Ocotal.

O. c. couesi appears to be a very widespread subspecies, and, except for the somewhat darker color, our specimens are typical of the race.

Oryzomys alfaroi palatinus Merriam

9 ♂ ♂, 7 ♀ ♀ (M.C.Z. 47303-47305, 47319-47330, 47355)

Although some of these smaller rice rats have a dorsal pelage dark enough to fit the description of *saturatior*, others are almost as pale as Panamanian specimens of *alfaroi*, which *palatinus* resembles in coloration. All of the Laguna Ocotal animals have whitish underparts, rather than the buffy ones ascribed to *saturatior*, and are hence referred to *palatinus*. As Goldman points out (1918), *palatinus* and *saturatior* inhabit the same mountain range, and intergradation between the two races is probable.

Ototylomys phyllotis guatemalae Thomas

3 ♂ ♂ (M.C.Z. 47301, 47302, 47386)

Two skins and skulls, and an additional single skull, were taken of this smaller genus of tree climbing rats. The diagnostic characters given by early authors (Merriam, 1901, Thomas, 1909, and Sanborn, 1935) do not hold when applied to the present specimens and the descriptions by Laurie (1953) were not sufficiently definitive to clarify the situation. Furthermore, the published records of the distribution of this group are confused.

Although these animals are generally rare in collections, it was possible to borrow seventy specimens, including one series from Esmeralda, Quintana Roo, Mexico, and another from Uaxactún, Petén, Guatemala. Examination of these specimens showed that *Ototylomys* could be divided into two groups. One

group consists of a smaller animal with an upper molar tooth row measuring 5.9 to 6.5 mm., from the Yucatán Peninsula south to Petén, and the other group consists of a larger animal with an upper tooth row of 6.9 to 7.5 mm., from Chiapas and Alta Vera Paz. Our specimens belong to the group of larger mammals which also include *connectens* and *guatemalae*. Sanborn states that *connectens* is the only race in which the belly hairs have slaty bases. However, in eight specimens within the stated range of *connectens* the bases of the hair of the belly vary from slaty gray (Finca Chama and Chimoxan, Guatemala) to almost pure white (Concepción). Furthermore, two specimens of *guatemalae* from Palenque, Chiapas, show a slaty cast of the belly fur, particularly in the midline.

Our specimens from Laguna Ocotal also have slaty based fur on the belly, otherwise they are closest to Thomas' description of *guatemalae*. They are too small to be referred to Sanborn's *connectens* and hence are considered to be the former race. It seems apparent, however, that *Ototylomys* shows considerable variation within a relatively small geographic area, and it is suspected that some of the characters which have been used to separate races will be found not to hold when more specimens are available for comparison.

Peromyscus mexicanus teapensis Osgood

8 ♂ ♂, 3 ♀ ♀ (M.C.Z. 47308-47318)

According to Osgood (1909) the various races of *mexicanus* are only slightly differentiated. The Laguna Ocotal specimens are referred to *teapensis* on the basis of color as well as on geographic grounds. Although the pelage is very much darker, the skulls closely resemble a series of *mexicanus* from Veracruz, in that they lack the broader nasals, heavier rostrum, and more massive molars ascribed to *teapensis*. Kuns and Tashian (1954), while identifying their specimens from Palenque as *teapensis*, also noted that the skulls showed no evidence of the thickened rostrum.

Sigmodon hispidus saturatus V. Bailey

2 ♀ ♀ (M.C.Z. 47306, 47307)

One adult cotton rat and one subadult were collected. Both animals are very similar to specimens in the M.C.Z. collection from British Honduras, except that the tips of the belly hairs of the adult are generally more whitish than yellowish. Laguna Ocotal lies well within the range of this widespread subspecies.

Nasua narica narica (Linnaeus)

1 ♀ (M.C.Z. 47277)

One very young coati with the third molars still unerupted resembles very closely older specimens of *narica* in color of pelage.

Odocoileus virginianus subsp.

Robert Dressler found fragments of two tibiae, two femora, one scapula and one vertebra (M.C.Z. 47476-47481) of white-tailed deer in an Indian rock shelter near the camp at Laguna Ocotal. Paynter found no evidence that this deer occurs naturally in the area, and it appears probable that the remains may have been carried there by travelling Indians. Associated with the bones were shells of varieties of snails found in the nearby lake and more distant streams.

Mazama sp.

Bones of these small deer were also found in the rock shelter by Dressler, along with those of the larger white-tail. *Mazama* fragments consisted of a ramus, a scapula, and a vertebra (M.C.Z. 47482-47484).

Brocket deer were seen by Paynter several times in the "burn" near the camp at Laguna Ocotal. One particular spot was noted where single animals were found bedded down on a number of occasions.

Dasypus novemcinctus subsp.

The shell of one animal was found near camp, and one live armadillo was seen in the area.

Tapirella bairdii (Gill)

One tapir was seen, but not collected, at El Censo. Footprints were seen around the shore of Laguna Ocotal. Natives reported that they were very numerous around the lake during the dry season.

LIST OF REFERENCES

Allen, J. A.

1901. A preliminary study of the North American opossums of the genus *Didelphis*. Bull. Amer. Mus. Nat. Hist., **14**:149-188.

1902. A preliminary study of the South American opossums of the genus *Didelphis*. Bull. Amer. Mus. Nat. Hist., **16**:249-279.

Andersen, Knud

1908. A monograph of the chiropteran genera *Uroderma*, *Enchisthenes*, and *Artibeus*. Proc. Zool. Soc. London, 1908, pp. 204-319.

Bailey, Vernon

1902. Synopsis of the North American species of *Sigmodon*. Proc. Biol. Soc. Washington, **15**:101-116.

Goldman, Edward A.

1911. Revision of the spiny pocket mice (genera *Heteromys* and *Liomys*). U. S. Dept. Agric., North Amer. Fauna no. 34, 70 pp.

1918. The rice rats of North America (genus *Oryzomys*). U. S. Dept. Agric., North Amer. Fauna no. 43, 100 pp.

Goodwin, George G.

1934. Mammals collected by A. W. Anthony in Guatemala, 1924-1928. Bull. Amer. Mus. Nat. Hist., **68**(1): 1-60.

Hershkovitz, Philip

1951. Mammals from British Honduras, Mexico, Jamaica and Haiti. Chicago Nat. Hist. Mus., Fieldiana: Zoology, **31**(47):547-569.

Kellogg, Remington, and E. A. Goldman

1944. Review of the spider monkeys. Proc. U.S. Nat. Mus., **96**(3186): 1-45.

Kelson, Keith R.

1952. The subspecies of the Mexican red-bellied squirrel, *Sciurus aureogaster*. Univ. Kansas Publ., Mus. Nat. Hist., **5**(17):243-250.

Kuns, Merle L., and Richard E. Tashian
1954. Notes on mammals from northern Chiapas, Mexico. Jour. Mamm., **35**(1):100-103.

Laurie, Eleanor M. O.
1953. Rodents from British Honduras, Mexico, Trinidad, Haiti and Jamaica collected by Mr. I. T. Sanderson. Ann. Mag. Nat. Hist., (12)**6**:382-394.

Lawrence, Barbara
1933. Howler monkeys of the *palliata* group. Bull. Mus. Comp. Zool., **75**(8):315-354.

Merriam, C. Hart
1901. Seven new mammals from Mexico, including a new genus of rodents. Proc. Washington Acad. Sci., **3**:559-563.

Murie, Adolph
1935. Mammals from Guatemala and British Honduras. Univ. Michigan Mus. Zool., Misc. Publ. no. 26, 30 pp.

Nelson, E. W.
1899. Revision of the squirrels of Mexico and Central America. Proc. Washington Acad. Sci., **1**:15-106.

Osgood, Wilfred H.
1909. Revision of the mice of the American genus *Peromyscus*. U. S. Dept. Agric., North Amer. Fauna no. 28, 285 pp.

Sanborn, Colin Campbell
1935. New mammals from Guatemala and Honduras. Field Mus. Nat. Hist., Zool. Ser., **20**(11):81-85.

Thomas, Oldfield
1909. A new rat from Guatemala. Proc. Zool. Soc. London. 1909. pp. 669-670.

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THE GENUS *TETRAGNATHA* (ARANEAE, ARGIOPIDAE) IN PANAMA

By Arthur M. Chickering
Albion College, Albion, Michigan

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No. 5 — *The Genus Tetragnatha (Araneae, Argiopidae) in Panama*

By Arthur M. Chickering

Albion College, Albion, Michigan

As a result of several visits to the Canal Zone and the Republic of Panama for the purpose of collecting and studying spiders I have accumulated a rather large number of specimens belonging to the interesting genus *Tetragnatha* Latreille, 1804. The present study of the genus is specifically concerned with its occurrence in Panama where it appears to have found exceptionally favorable conditions.

Araneologists who have interested themselves in the genus *Tetragnatha* have emphasized such characters as the following: size of the body; shape of the abdomen; relative position of the eyes; several features of the chelicerae and cheliceral teeth; color; relative lengths of the different segments of the male palp; specific characteristics of the male palpal tarsus; presence or absence of spines on legs and their length. F. P. Cambridge (1903) paid close attention to the characters and relationships of the conductor and embolus in male palps. Petrunkevitch (1930) also did this and, in addition, gave careful attention to the appearance of the genital fold in females which are often difficult to place with certainty because of the absence of an epigynum and other marked characteristics. My experience with the genus seems to show that close attention must always be given to the specific shape of the conductor and embolus as well as to their relationships. These features appear to be the least variable among all of those used by taxonomists and, therefore, the most reliable for purposes of accurate determination. In females the characters of the genital fold are often very helpful. Size; color; number, relative size, and placement of the cheliceral teeth are all subject to a rather wide range of variation. These facts seem to explain the numerous errors in identification which can be found in almost every collection. In making this study I have tried to take into consideration all of these items in making my identifications and in drawing conclusions regarding synonymy.

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Genus TETRAGNATHA Latreille, 1804

The Cambridges (1889-1903) reported the following species of this genus in Panama: *T. alba* F. P. Cambridge; *T. pallida* O. P. Cambridge; *T. tenuis* O. P. Cambridge; *T. tenuissima* O. P. Cambridge. Petrunkevitch (1925) added *T. antillana* Simon to the known list from Panama, and Banks (1929) recorded *T. mexicana* Keyserling. Chamberlin and Ivie (1936) described four new species from my first collection of Panamanian spiders made in 1928.

T. alba F. P. Cambridge has proven to be a synonym for *T. laboriosa* Hentz. *T. amplidens* Chamberlin and Ivie and *T. siduo* Chamberlin and Ivie are synonyms for *T. tropica* O. P. Cambridge. The male of *T. apheles* Chamberlin and Ivie belongs with *T. mexicana* Keyserling but the female is a *T. antillana* Simon. *T. ethodon* Chamberlin and Ivie appears to be a valid species. To the best of my knowledge, therefore, the total list of known species of *Tetragnatha* from Panama prior to this study may be stated as follows: *T. antillana* Simon; *T. ethodon* Chamberlin and Ivie; *T. laboriosa* Hentz; *T. mexicana* Keyserling; *T. pallida* O. P. Cambridge; *T. tenuis* O. P. Cambridge; *T. tenuissima* O. P. Cambridge; *T. tropica* O. P. Cambridge.

As a result of my studies on this genus I have definitely recorded the following additional known species to the list: *T. caudata* Emerton; *T. cognata* O. P. Cambridge; *T. confraterna* Banks; *T. guatemalensis* O. P. Cambridge; *T. pallescens* F. P. Cambridge; *T. vermiformis* Emerton. In addition to these I have been compelled to recognize and describe *T. fragilis* sp. nov.; *T. gertschi* sp. nov.; *T. mabelae* sp. nov.; *T. sinuosa* sp. nov. Thus the total number of species of *Tetragnatha* now known to occur in Panama amounts to eighteen.

No attempt is made in this paper to give complete bibliographic references. Only those which are regarded as particularly pertinent are included. Those who desire more extensive bibliographies are referred to Roewer (1942).

Types will be deposited in the Museum of Comparative Zoology at Harvard College.

Key to the Species of Tetragnatha in Panama

Males

1. ALE distinctly further from PLE than AME are from PME (*caudata, fragilis, mexicana, pallescens, vermiformis*) 2
1. ALE not distinctly further from PLE than AME are from PME (*antillana, cognata, confraterna, ethodon, gertschi, guatemalensis, laboriosa, mabelae, pallida, sinuosa, tenuis, tenuissima, tropica*) .. 6
2. With abdomen considerably extended posterior to spinnerets ..... *T. caudata*, p. 308
2. With abdomen not extended any appreciable distance posterior to spinnerets 3
3. With palpal tibia distinctly longer than palpal patella (*mexicana, pallescens*) 4
3. With palpal tibia not much longer than palpal patella (*fragilis, vermiformis*) 5
4. Promargin of fang groove with the "large tooth"[1] well developed ..... *T. pallescens*, p. 336
4. Promargin of fang groove without any "large tooth" ..... *T. mexicana*, p. 333
5. A smaller species (about 5-7 mm.); paracymbium distinctly bifid distally; with no spines on legs ..... *T. fragilis*, p. 317

[1] The term "large tooth" is being used in the sense in which F. P. Cambridge employed it. In certain species there is an enlarged promarginal tooth at about the "apical third or fourth."

5. A larger species (7-9 mm.); paracymbium not bifid distally; legs with spines ..... *T. vermiformis*, p. 349
6. With no spines on legs; only a fine coating of hair..... .... *T. tenuissima*, p. 344
6. With spines on all legs as well as a supply of hair (*antillana, cognata, confraterna, ethodon, gertschi, guatemalensis, laboriosa, mabelae, pallida, sinuosa, tenuis, tropica*) 7
7. With palpal tibia much longer than palpal patella (*antillana, guatemalensis, pallida, tenuis, tropica*) 8
7. With palpal tibia not much longer than palpal patella (*cognata, confraterna, ethodon, gertschi, laboriosa, mabelae, sinuosa*.....12
8. Paracymbium bifid distally .....*T. antillana*, p. 306
8. Paracymbium not bifid distally (*guatemalensis, pallida, tenuis, tropica*) 9
9. Paracymbium extended distally into a vermiform termination ....*T. guatemalensis*, p. 326
9. Paracymbium not distally vermiform (*pallida, tenuis, tropica*) 10
10. The "large tooth" proper well developed (see note, p. 303) ....*T. tropica*, p. 347
10. The "large tooth" proper not present (*pallida, tenuis*) 11
11. The conductor, embolus, and cymbium all long, slender, nearly straight (Fig. 78) ....*T. pallida*, p. 338
11. The conductor, embolus, and cymbium all at least somewhat sinuous (See F. P. Cambridge's Figs. 1 and 1A, Plate 41) ..*T. tenuis*, p. 342
12. With abdomen extended a short distance posterior to spinnerets..... ....*T. confraterna*, p. 312
12. With abdomen not extended posterior to spinnerets (*cognata, ethodon, gertschi, laboriosa, mabelae, sinuosa*) 13
13. The promargin of fang groove with a very large, massive tooth at base of fang (Fig. 85) .....*T. sinuosa*, p. 340
13. The promargin of fang groove without any very large, massive tooth at base of fang (*cognata, ethodon, gertschi, laboriosa, mabelae*)..14
14. With the paracymbium somewhat serrated distally (Fig. 64)..... ....*T. mabelae*, p. 330
14. With paracymbium not serrated distally (*cognata, ethodon, gertschi, laboriosa*) 15
15. Bulb of palpal tarsus distinctly inflated (Fig. 39) ....*T. gertschi*, p. 321
15. Bulb of palpal tarsus not unusually inflated (*cognata, ethodon, laboriosa*) 16
16. Paracymbium distinctly notched distally . .....*T. ethodon*, p. 316
16. Paracymbium without distal notch (*cognata, laboriosa*) 17

17. Conductor with a cap-like distal termination (Fig. 56) .... *T. laboriosa*, p. 329
17. Conductor without a cap-like distal termination; with a bluntly rounded termination ... . *T. cognata*, p. 310

Females

Because of the lack of distinctive features in females it is difficult to provide readily workable keys. It is hoped, however, that the following key will aid the student of the group in separating the females of the different species.

1. ALE distinctly further from PLE than AME are from PME (*caudata, fragilis, mexicana, pallescens, vermiformis*) 2
1. ALE not distinctly further from PLE than AME are from PME (*antillana, cognata, confraterna, gertschi, guatemalensis, laboriosa, pallida, tenuis, tenuissima, tropica*) 6
2. Abdomen considerably extended posterior to spinnerets .... *T. caudata*, p. 308
2. Abdomen not noticeably extended posterior to spinnerets (*fragilis, mexicana, pallescens, vermiformis*) 3
3. Spines completely lacking from all legs ..... *T. fragilis*, p. 317
3. Spines present on all legs (*mexicana, pallescens, vermiformis*) 4
4. Genital fold considerably longer than wide .... *T. vermiformis*, p. 349
4. Genital fold wider than long (*mexicana, pallescens*) 5
5. Genital fold very gently procurved (Fig. 70) ..... *T. mexicana*, p. 333
5. Genital fold strongly procurved, fully twice as wide as long (Fig. 75) .... *T. pallescens*, p. 336
6. Spines completely lacking from all legs ..... *T. tenuissima*, p. 344
6. Spines present on all legs (*antillana, cognata, confraterna, gertschi, guatemalensis, laboriosa, pallida, tenuis, tropica*) 7
7. Retromargin of fang groove with a much enlarged tooth at base of fang directed forward (Fig. 6) ..... *T. antillana*, p. 306
7. Retromargin of fang groove without a greatly enlarged tooth at base of fang directed forward (*cognata, confraterna, gertschi, guatemalensis, laboriosa, pallida, tenuis, tropica*) 8
8. Genital fold fully twice as long as wide (Fig. 26) .... *T. confraterna*, p. 312
8. Genital fold much less than twice as long as wide (*cognata, gertschi, guatemalensis, laboriosa, pallida, tenuis, tropica*) 9
9. Basal segment of chelicera nearly as long as carapace; basal segment of chelicera with an unusual dorsal blunt tooth near base of fang (Fig. 100) ..... *T. tropica*, p. 347

9. Basal segment of chelicera much shorter than carapace; basal segment of chelicera without any dorsal distal tooth near base of fang (*cognata, gertschi, guatemalensis, laboriosa, pallida, tenuis*) 10
10. ALE definitely closer to PLE than AME are to PME (*cognata, gertschi, guatemalensis*) 11
10. ALE not closer to PLE than AME are to PME (*laboriosa, pallida, tenuis*) 13
11. A larger species, 9-11 mm.; fang with a dorsal basal cusp ....*T. guatemalensis*, p. 326
11. Smaller species, from 5-8 mm.; fang without a dorsal basal cusp (*cognata, gertschi*) 12
12. Abdomen deeply notched at base dorsally .....*T. cognata*, p. 310
12. Abdomen unnotched at base dorsally .....*T. gertschi*, p. 321
13. Abdomen conspicuously silvery on dorsal and dorsolateral sides, with a dark median ventral stripe and a silvery stripe on each side of the dark stripe .....*T. laboriosa*, p. 329
13. Abdomen not conspicuously silvery and without the ventral stripes as in *laboriosa* (*pallida, tenuis*) 14
14. ALE about as far from PLE as AME are from PME; with long robust leg spines .....*T. pallida*, p. 338
15. ALE slightly further from PLE than AME are from PME; with relatively weak leg spines .....*T. tenuis*, p. 342

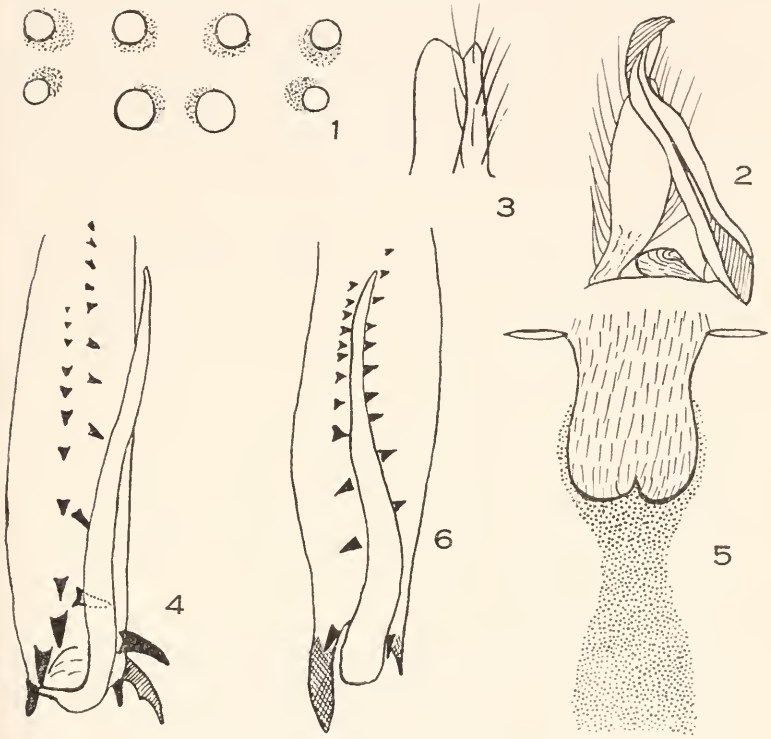
Tetragnatha antillana Simon, 1897
(Figures 1-6)

T. antillana Banks, 1901
T. antillana F. P. Cambridge, 1903
T. antillana Petrunkevitch, 1911
T. eremita Chamberlin, 1924
T. antillana Seeley, 1928
T. antillana Petrunkevitch, 1930
T. apheles Chamberlin and Ivie, 1936 (female only)
T. festina Bryant, 1945 (male only)
T. haitiensis Bryant, 1945 (females)
T. antillana Kraus, 1955

T. antillana Simon is well known throughout Mexico, Central America, most of South America, and the West Indies. The vial in the collection of the Museum of Comparative Zoology labelled the type of *T. eremita* Chamberlin now contains only a single male palp but this is very definitely from *T. antillana* Simon. The female about which Dr. Chamberlin had some doubts also

clearly belongs here. Moreover, the female of *T. apheles* Chamberlin and Ivie is quite clearly a *T. antillana* Simon.

Male: Lateral eyes somewhat closer to one another than AME are to PME; legs well supplied with short spines; palpal patella about two-thirds as long as palpal tibia; the conductor and



External Anatomy of *Tetragnatha*

Figures 1-6, *T. antillana*

Fig. 1. Eye group from in front.
Fig. 2. Distal ends of conductor, embolus, and cymbium.
Fig. 3. Distal end of paracymbium.
Fig. 4. Chelicera and teeth of male.
Fig. 5. Genital fold and genital area, female.
Fig. 6. Chelicera and teeth of female.

embolus as shown in Figure 2; the paracymbium is distally bifurcate (Fig. 3); the fang is moderately sinuous and is without a basal dorsal cusp but there is a suppressed tubercle on the inner margin opposite the third promarginal tooth; there is no "large tooth" on the promargin but the spur together with the two contiguous teeth forms a conspicuous group of three (Fig. 4).

Female: The genital fold is as shown in Figure 5; the retromargin of the fang groove has a large distinctive tooth directed forward with a small tooth near it (Fig. 6); the promargin has a similar pair of distal but smaller teeth; the fang is moderately sinuous and there may be a suppressed dorsolateral cusp near its base; the abdomen is not extended posterior to the spinnerets in either sex.

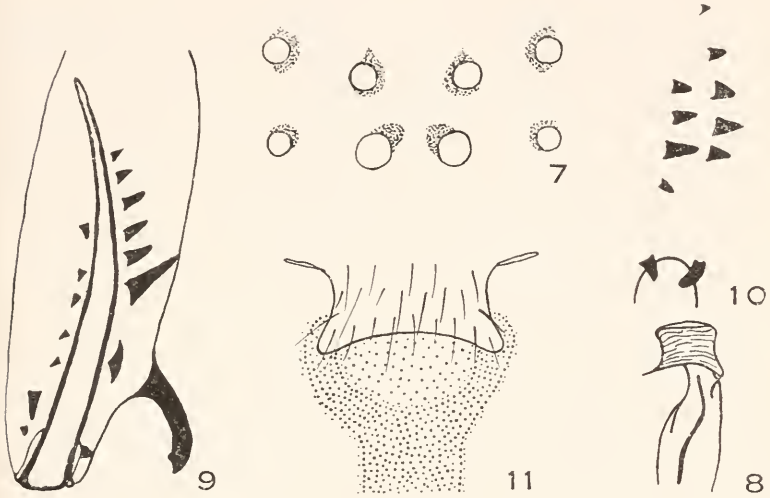
Collection records: The male and female hypotypes are from Boquete, R. P., August, 1950 and July, 1939, respectively. Numerous examples of both sexes from Boquete, R. P., July, 1939, August, 1950; El Valle, R. P., July, 1936; El Volcan, R. P., February-April, 1936 (W. J. Gertsch); one female from Madden Dam Forest, C. Z., July, 1950.

Tetragnatha caudata Emerton, 1884
(Figures 7-11)

Eucta lacerta Petrunkevitch, 1911
T. caudata Seeley, 1928
T. caudata Bryant, 1940
T. lacerta Roewer, 1942
T. caudata Kaston, 1948

For some time this species was considered as new and was scheduled to be described as such. After careful comparison with *T. caudata* from the northern regions the close similarities seemed to warrant regarding it as a southern variant of this species. Further knowledge regarding it may compel araneologists to regard it as a separate species. *T. caudata* Emerton has been recorded from Maine to Florida along the Atlantic coast, from Canada, through several middle Western states, and in the south as far west as Mississippi. It is interesting to find it now in Panama and not where it would be expected to come in with goods shipped from the north. The most distinctive features of the species are given below.

Male: ALE considerably further from PLE than AME are from PME (Fig. 7); palpal patella only a little shorter than palpal tibia; the conductor terminates in a broad distal piece (differing considerably from that in northern forms) (Fig. 8); the paracymbium is bluntly rounded distally; the prolateral spur is indistinctly bifid; the "large tooth" is present and the other cheliceral teeth are as shown in Figure 9; the fang has no cusps; the abdomen is considerably extended beyond the spinnerets; leg spines are few and weak.



External Anatomy of *Tetragnatha*

Figures 7-11, *T. caudata*

Fig. 7. Eye group from in front.
Fig. 8. Apex of conductor and embolus of male.
Fig. 9. Male chelicera and cheliceral teeth.
Fig. 10. Female cheliceral teeth from below.
Fig. 11. Genital fold of female.

Female: Cheliceral teeth as shown in Figure 10; the genital fold as shown in Figure 11; abdomen extended posterior to spinnerets for about one-fifth of the total length of the organ; male hypotype 6.05 mm. long; female hypotype 9.36 mm. long.

Collection records: The hypotypes are from Boquete, Chiriqui, R. P., August, 1950. Two other females are in the collection and taken at the same place and time, together with a single female from this locality taken in August, 1954.

Tetragnatha cognata O. P. Cambridge, 1889
(Figures 12-18)

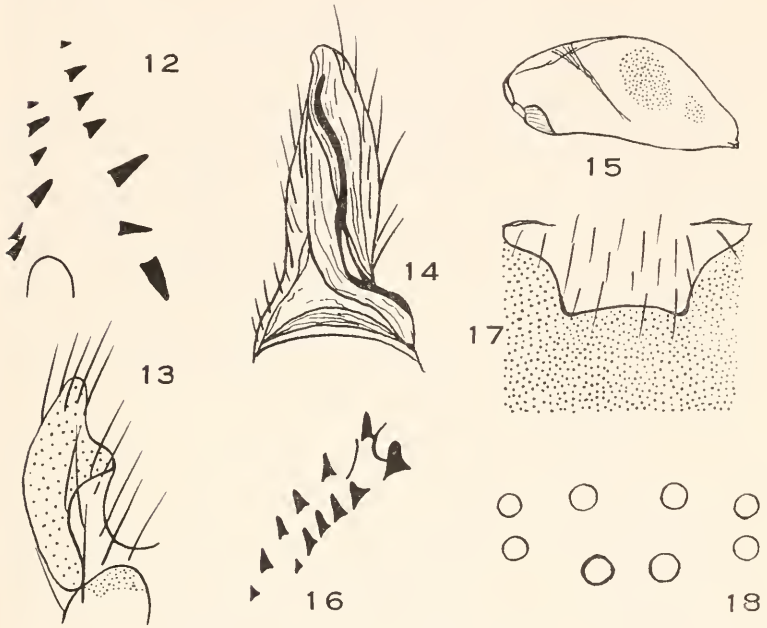
T. cognata F. P. Cambridge, 1903
T. cognata Petrunkevitch, 1911
T. cognata Roewer, 1942

Apparently this species has not been studied since the original work done by the Cambridges and, hence, it seems desirable to give a condensed description of hypotypes as follows:

Male hypotype. Total length 4.160 mm. exclusive of chelicerae; including chelicerae 4.875 mm. Abdomen widest about two-fifths from base; does not extend posterior to spinnerets. Legs comparatively robust; with both spines and hairs. Ratio of eyes AME : ALE : PME : PLE = 3.5 : 2.5 : 3.5 : 3.5. Lateral eyes separated from one another by the diameter of ALE. AME separated from PME by nearly twice as far. Carapace longer than basal segment of chelicerae in ratio of about 3 : 2. Chelicerae: relatively short and robust; the fang has a cusp on its inner margin near the base; the prolateral spur is a simple and fairly robust spine; the promargin of the fang groove has six teeth of which the second is considerably enlarged and could well be considered the "large tooth" in the usual sense but F. P. Cambridge did not so regard it; the retromargin has six teeth with the first two close together (Fig. 12). Legs with both spines and hair. Palp: the tibia is only slightly longer than the patella; the paracymbium is relatively short and broad except terminally where it narrows to a blunt apex (Fig. 13); the conductor is broad throughout its length (Fig. 14). The hypotype male is colored essentially like the hypotype female but is lighter throughout.

Hypotype female. Total length exclusive of the chelicerae 5.265 mm.; inclusive of the chelicerae 5.525 mm. Abdomen very gibbous about the middle (Fig. 15); gibbosity lacking in some individuals which may not be mature; not continued posterior to spinnerets. Chelicerae: short, robust; fang without inner or

outer cusps; promargin of fang groove with seven teeth[1]; retromargin with six (Fig. 16). Some variation in respect to number and placement of teeth has been noted in both sexes. When the female is fully mature the genital fold appears as shown in Figure 17. The eyes are essentially as they appear in the male (Fig. 18).



External Anatomy of *Tetragnatha*

Figures 12-18, *T. cognata*

Fig. 12. Left male cheliceral teeth.
Fig. 13. Male paracymbium.
Fig. 14. Male conductor, embolus, and distal end of cymbium.
Fig. 15. Lateral view of female abdomen.
Fig. 16. Left female cheliceral teeth. (See footnote)
Fig. 17. Genital fold of female.
Fig. 18. Eye group of female from in front.

[1] In Figure 16 there should be an additional minute tooth a short distance proximal to the sixth tooth on the promargin (upper side).

Collection records: The hypotypes are from Boquete, Chiriqui, R. P., August, 1954. Numerous examples of both sexes from Boquete, R. P., July, 1939, August, 1950, 1954; El Volcan, Chiriqui, R. P., August, 1950; Canal Zone Experiment Gardens, C. Z., August, 1954; Summit, C. Z., August, 1950.

Tetragnatha confraterna Banks, 1909
(Figures 19-26)

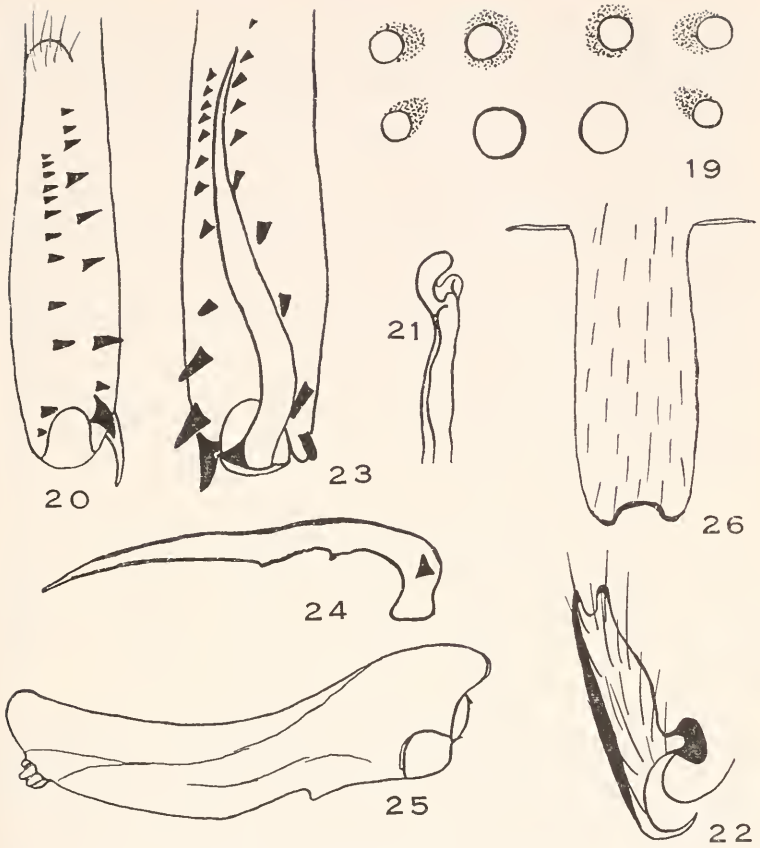
T. confraterna Petrunkevitch, 1911
T. confraterna, Roewer, 1942

This species was described by its author from Costa Rica with great brevity and accompanied by a very simple figure of the male chelicera. The species has received no attention since 1909 and would seem to deserve a detailed description which is given below in accord with my usual formula.

Male hypotype. Total length exclusive of the chelicerae 8.775 mm.; inclusive of the chelicerae about 10.92 mm. Carapace 3.12 mm. long, 1.722 mm. wide opposite posterior border of second coxae where it is widest; cephalic part only slightly raised; with other features as usual in the genus.

Eyes. Ocular tubercle bearing AME rather prominent; viewed from above, both rows moderately recurved; viewed from in front, anterior row slightly recurved, posterior row nearly straight, both measured by centers; central ocular quadrangle wider behind than in front in ratio of 6 : 5, wider behind than long in ratio of 6 : 5. Ratio of eyes AME : ALE : PME : PLE = 6 : 3 : 4.25 : 4. AME separated from one another by slightly more than their diameter, from ALE by slightly more than 1.3 times their diameter. PME separated from one another by slightly less than 2.5 times their diameter, from PLE by twice their diameter. Laterals separated from one another by the diameter of AME. AME separated from PME by slightly more than the distance between the laterals (Fig. 19). Height of clypeus equal to 1.5 times the diameter of AME.

Chelicerae. Strongly developed, quite porrect, and moderately divergent; basal segment 2.73 mm. long and, therefore, somewhat shorter than carapace; fang long, slender, only slightly sinuous, without cusps; the prolateral spur is simple, without



External Anatomy of *Tetragnatha*

Figures 19-26, *T. confraterna*

Fig. 19. Eye group of male from in front.
Fig. 20. Left chelicera and cheliceral teeth of male.
Fig. 21. Distal end of male conductor and embolus.
Fig. 22. Paracymbium of male.
Fig. 23. Left chelicera and cheliceral teeth of female.
Fig. 24. Fang of female.
Fig. 25. Lateral side of female abdomen.
Fig. 26. Genital fold of female.

bifurcation or a tooth; the promargin of the fang groove bears nine teeth with the first robust and the second small; the retromargin has twelve teeth; the teeth are spaced essentially as shown in Figure 20. There is no "large tooth" on the promargin of the fang groove.

Maxillae. Longer than lip in ratio of 45 : 19. Otherwise essentially as usual in the genus.

Lip. Nearly as long as wide at base. Sternal suture gently procurved; with sternal tubercles as usual at ends of sternal suture.

Sternum. Longer than wide in ratio of about 4 : 3; posterior coxae separated by slightly more than one-third of their width. Otherwise essentially as usual in the genus.

Legs. 1243. Width of first patella at "knee" .330 mm., tibial index of first leg 4. Width of fourth patella at "knee" .308 mm., tibial index of fourth leg 6.

	Femora	Patellae	Tibiae	Metatarsi	Tarsi	Totals
		(All measurements in millimeters)				
1.	7.865	1.175	8.060	8.710	1.755	27.565
2.	5.590	.975	4.745	4.875	1.150	17.355
3.	2.600	.552	1.625	2.080	.645	7.502
4.	6.045	.715	4.485	4.810	.950	17.005
Palp	1.826	.660	.704	——	1.144	4.334

Legs are provided with both spines and hairs.

Palp. Tibia only slightly longer than patella; the paracymbium is notched distally with the chitinous knob somewhat closer to the base than to the apex; the conductor is rather slender and terminates characteristically at its distal end (Figs. 21-22).

Abdomen. Definitely extended a short distance posterior to spinnerets; only slightly enlarged near base; without any dorsal basal notch; only overlaps carapace slightly; 6.305 mm. long.

Color in alcohol. Legs and chelicerae yellowish with some irregular grayish markings at joints. Maxillae yellowish along median borders, grayish elsewhere. Lip and sternum grayish. Carapace with a broad dusky gray median stripe and grayish bands radiating from the median pit; also with a broad dusky stripe along the border. Abdomen: the dorsum is light colored with many yellowish silvery spangles and dusky areas; lateral

sides with narrow, irregular, grayish lines; venter light yellowish.

Female hypotype. Total length exclusive of the chelicerae 13 mm.; including the chelicerae 15.60 mm. Carapace 3.055 mm. long, 2.21 mm. wide opposite second coxae where it is widest.

Eyes. Essentially as in male.

Chelicerae. Basal segment 2.925 mm. long and, therefore, slightly shorter than carapace; fang robust, markedly sinuous and with a robust dorsolateral cusp near base and a smaller inner cusp about one-fourth from base; promargin of fang groove with ten teeth; retromargin with twelve teeth the first of which is the largest (Figs. 23-24); all spaced essentially as shown in figures.

Maxillae, Lip, and *Sternum.* All essentially as in male.

Legs. 1243. Width of first patella at "knee" .525 mm., tibial index of first leg 5. Width of fourth patella at "knee" .352 mm., tibial index of fourth leg 6.

	Femora	Patellae	Tibiae	Metatarsi	Tarsi	Totals
		(All measurements in millimeters)				
1.	8.645	1.430	8.840	9.750	1.950	30.615
2.	5.785	1.170	5.200	5.700	1.235	19.110
3.	3.055	.660	1.820	2.405	.780	8.720
4.	6.370	.910	5.005	5.070	.810	18.165

All legs with spines and hair as in male.

Abdomen. Definitely extends a short distance posterior to spinnerets; considerably swollen in anterior third and quite concave dorsally (concavity varies considerably among available specimens) (Fig. 25); slightly notched at base above; 10.075 mm. long; genital fold essentially as shown in Figure 26 but lateral margins indistinct.

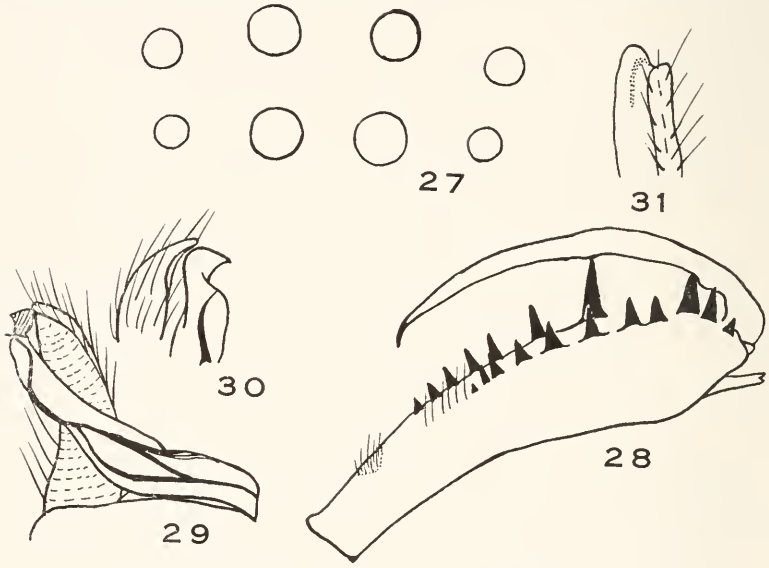
Color in alcohol. Essentially as in male but in general is considerably lighter with dark abdominal markings practically absent.

Type locality. Both hypotypes from Barro Colorado Island, C. Z., June, 1939. Numerous examples of both sexes from Barro Colorado Island, June, 1934; February, 1936 (W. J. Gertsch); June, 1936; June and August, 1939; July, 1950.

Tetragnatha ethodon Chamberlin and Ivie, 1936
(Figures 27-31)

T. ethodon Roewer, 1942

As I have pointed out elsewhere, the females regarded by the authors of this species as the allotype and paratypes actually belong to *T. tenuissima* O. P. Cambridge. The absence of spines on the legs, the cheliceral teeth, and the genital fold as well as other less marked characteristics make this identification certain.



External Anatomy of *Tetragnatha*

Figures 27-31, *T. ethodon*

Fig. 27. Eye group of male from in front.
Fig. 28. Left male chelicera and cheliceral teeth from below.
Fig. 29-30. Two views of distal parts of male conductor, embolus, and cymbium.
Fig. 31. Distal end of male paracymbium.

The holotype male appears to represent a valid species and is so regarded in this paper. It seems strange, however, that only one specimen has been taken in view of the repeated extensive

collecting practiced during the past twenty-eight years. The male holotype is rather badly mutilated and, hence, it is impossible to describe it as carefully as desired. The following items may be useful additions to the very brief description given by the authors of the species.

Eyes. Viewed from above, both rows moderately recurved; viewed from in front, anterior row nearly straight and posterior row gently procurved, both measured by centers. Central ocular quadrangle slightly wider behind than in front, slightly wider behind than long. Ratio of eyes AME : ALE : PME : PLE = 12 : 8 : 10 : 9. AME separated from one another by their diameter, from ALE by about five-fourths of their diameter. PME separated from one another by about 1.7 times their diameter, from PLE by slightly less than this. Laterals separated from one another by five-fourths of the diameter of ALE. Laterals, therefore, slightly closer to one another than AME are to PME. Height of clypeus equal to about five-fourths of the diameter of AME.

Chelicerae. The "large tooth" is present; the prolateral spur is bifid; the cheliceral teeth along the fang groove are as shown in Figure 28.

Palp. Essentially as shown in figures provided by the authors of the species; some details relating to conductor, embolus, and paracymbium are shown in Figures 29-31.

Type locality. The holotype is from Barro Colorado Island, C. Z., July-August, 1928 (Chickering). No other specimens have come to light during several collecting periods since the finding of the holotype.

Tetragnatha fragilis sp. nov.
(Figures 32-38)

Male holotype. Total length including chelicerae 5.85 mm., exclusive of the chelicerae 5.395 mm. Carapace 1.527 mm. long, .780 mm. wide opposite second coxae where it is widest; cephalic part nearly parallel sided; other features as usual in the genus.

Eyes. Eight in two rows as usual, all dark; viewed from above, both rows definitely recurved; viewed from in front, both rows also moderately recurved, measured by centers. Central ocular quadrangle wider behind than in front in ratio of 13 : 11; wider

behind than long in nearly the same ratio. Ratio of eyes AME : ALE : PME : PLE = 7.5 : 5 : 6.5 : 6. AME separated from one another by about six-fifths of their diameter, from ALE by four-thirds of their diameter. PME separated from one another by slightly more than twice their diameter, from PLE by a little more than 1.5 times their diameter. Laterals separated from one another by a little more than twice the diameter of PLE. AME separated from PME by slightly more than 1.5 times the diameter of PME and, therefore, closer together than ALE are to PLE. Height of clypeus equal to about the diameter of AME.

Chelicerae. Well developed; strongly divergent; basal segment .910 mm. long; with a well-developed prolateral spur having a pair of blunt terminal tubercles; fang only slightly sinuous but conspicuously bowed near the middle; the promargin of the fang groove has the "large tooth" about one-third from the distal end, a small tooth distal to this and a series of five teeth proximal to it diminishing in size to very minute at the last (this series appears to be very variable among the paratypes); the retromargin has a relatively large hook-like tooth near the base of the fang and a series of five additional more proximal (only four of these on the right) (Figs. 32-33); paratypes frequently show only three proximal to the hook-like tooth on the retromargin.

Maxillae. Nearly parallel, somewhat broadened distally; somewhat concave along lateral surface in distal quarter; longer than lip in ratio of 23 : 10; somewhat more than three times as long as wide at narrowest level.

Lip. Longer than wide at base in ratio of about 9 : 8; sternal suture gently procurved; with the usual sternal tubercles at ends of sternal suture.

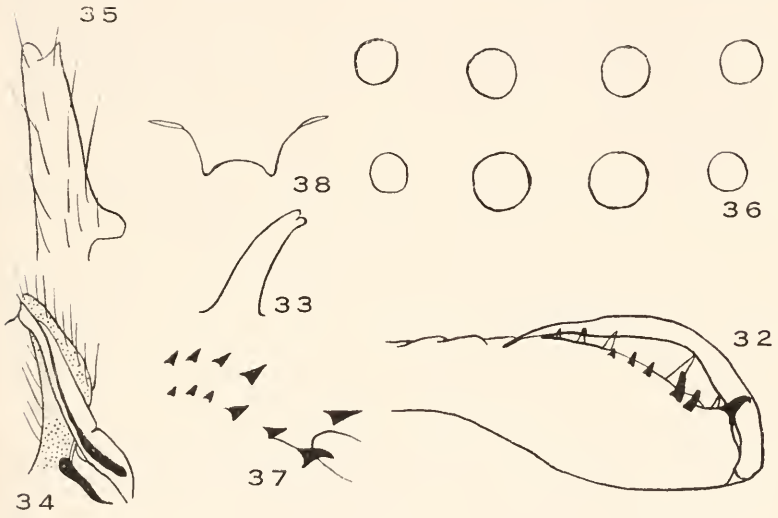
Sternum. Generally scutiform; moderately convex; longer than wide in ratio of about 37 : 25; moderately scalloped opposite each coxa and extended between all coxae, the second and third being relatively widely separated; continued as a narrow sclerite between fourth coxae which are separated by only one-eleventh of their width.

Legs. 1243. Width of first patella at "knee" .198 mm., tibial index of first leg 4. Width of fourth patella at "knee" .137 mm., tibial index of fourth leg 5.

	Femora	Patellae	Tibiae	Metatarsi	Tarsi	Totals
		(All measurements in millimeters)				
1.	4.745	.585	5.085	5.525	1.397	17.337
2.	3.120	.390	2.730	2.925	.900	10.065
3.	1.625	.242	.902	1.170	.520	4.459
4.	3.575	.292	2.275	2.470	.748	9.360
Palp	.748	.225	.264	——	.590	1.827

True spines are completely lacking from all legs.

Palp. The tibia is slightly longer than patella but both are short; the paracymbium is distinctly notched or bifid at its apex; the embolus describes nearly a circle on the bulb and then extends nearly straight to terminate at a point slightly beyond



External Anatomy of *Tetragnatha*

Figures 32-38, *T. fragilis*

Fig. 32. Left chelicera and cheliceral teeth of male from below.
Fig. 33. Prolateral spur of male.
Fig. 34. Distal parts of male cymbium, embolus, and conductor.
Fig. 35. Paracymbium of male.
Fig. 36. Eye group of female from in front.
Fig. 37. Cheliceral teeth of female.
Fig. 38. Genital fold of female.

the tip of the conductor which has a very characteristic form (Figs. 34-35). Both conductor and embolus are closely associated throughout.

Abdomen. Not continued posterior to spinnerets; only slightly extended over carapace; 3.802 mm. long; without any anterior dorsal notch at base; very slender and of nearly uniform diameter throughout; a little more than seven times as long as wide near base; genital fold only a transverse ridge.

Color in alcohol. Legs yellowish with extensive fine dusky gray dotting. Palps, chelicerae, and maxillae yellow with a variety of shading. Lip and sternum yellowish with dusky dotting. Carapace yellowish with a broad irregular dusky median stripe from posterior border nearly to PLE. Abdomen: dorsum yellowish white with a small median black spot just above the anal tubercle and four pairs of similar small black dorsolateral spots in the posterior three fourths (with some irregularities); there is a narrow dark gray lateral stripe on each side; the venter is a dusky gray.

Female allotype. Total length including chelicerae 7.67 mm. Carapace 1.82 mm. long, 1.25 mm. wide opposite second coxae where it is widest; otherwise essentially as in male.

Eyes. Essentially as in male (Fig. 36).

Chelicerae. Moderately robust; moderately divergent; scarcely porrect; basal segment .845 mm. long; fang without particularly conspicuous features; promargin of fang groove with a moderately large tooth near distal end and, after a long space, a series of four teeth diminishing in size toward the proximal end; retromargin with six teeth arranged and spaced essentially as shown in Figure 37. As usual there are variations in number and placement of cheliceral teeth among the paratypes; one paratype exhibits the same number and placement on the promargin but has seven teeth on the retromargin spaced somewhat differently also from those of the allotype.

Maxillae, Lip, and *Sternum.* Except for minor details, essentially as in male.

Legs. 12-43. Width of first patella at "knee" .220 mm., tibial index of first leg 4. Width of fourth patella at "knee" .154 mm., tibial index of fourth leg 5.

	Femora	Patellae	Tibiae	Metatarsi	Tarsi	Totals
	(All measurements in millimeters)					
1.	5.200	.660	5.265	5.265	1.300	17.690
2.	3.250	.520	2.795	2.860	.780	10.205
3.	1.820	.292	.910	1.170	.560	4.752
4.	3.510	.455	2.860	2.600	.780	10.205

Legs without true spines as in male.

Abdomen. Long and slender as in male; 5.58 mm. long; genital fold as shown in Figure 38.

Color in alcohol. Essentially as in male except that dusky areas are much less conspicuous; the single median dorsal spot just above anal tubercle as in male but the paired dorsolateral spots are only faintly indicated; the dorsal and dorsolateral areas are covered by many yellowish silvery spangles.

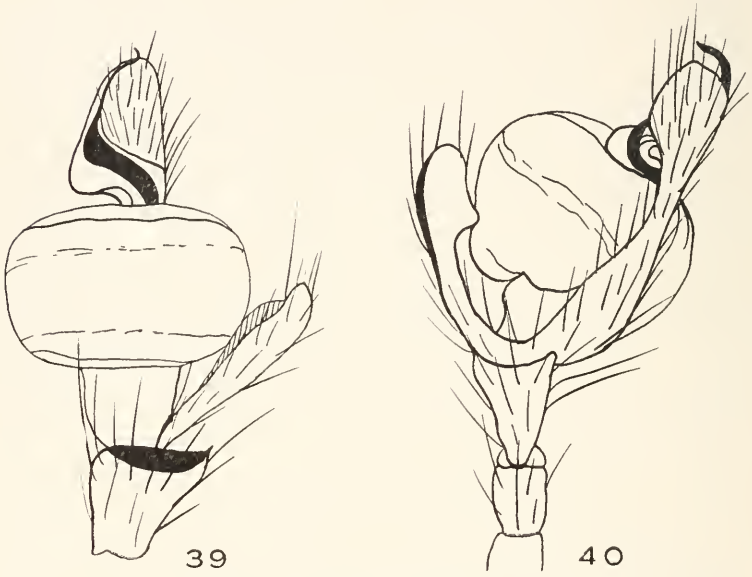
Type locality. Male holotype and female allotype from Barro Colorado Island, C. Z., August, 1936. Numerous paratypes of both sexes from Barro Colorado Island: June-August, 1936. July, 1950; July, 1954; Ft. Davis, C. Z., August, 1936; Balboa, C. Z., August, 1936; Pedro Miguel, C. Z., July, 1950; Madden Dam Forest, C. Z., August, 1939; C. Z. Forest Reserve, July-August, 1939 and July, 1950; Gamboa, C. Z., July, 1954; Summit, C. Z., July-August, 1950; C. Z. Experiment Gardens, C. Z., July-August, 1954. Arraijan, R. P., August, 1936; Porto Bello, R. P., August, 1936.

Tetragnatha gertschi, sp. nov.
(Figures 39-45)

Male holotype. Total length including chelicerae 5.395 mm. Carapace 2.015 mm. long; 1.365 mm. wide opposite second coxae where it is widest; with the usual form of the genus; .390 mm. tall and, therefore, about .29 as tall as wide; with cephalic region somewhat raised; with the usual shallow median pit with apex directed forward.

Eyes. Eight in two rows, all dark; ocular tubercle bearing LE quite prominent; viewed from above, both rows moderately recurved; viewed from in front, anterior row gently recurved and posterior row gently procurved, both measured by centers; central ocular quadrangle wider behind than in front in ratio of 4 : 3, wider behind than long in ratio of 6 : 5. Ratio of eyes

AME : ALE : PME : PLE = 4 : 3.25 : 4.75 : 4. AME separated from one another by seven-fourths of their diameter, from ALE by eleven-fourths of their diameter. PME separated from one another by nearly twice their diameter, from PLE by nearly the same distance. Laterals separated from one another by about two-thirds of the diameter of ALE and, therefore, much closer to one another than AME are to PME. Height of clypeus nearly equal to the diameter of AME.



External Anatomy of *Tetragnatha*

Figures 39-40, *T. gertschi*

Fig. 39. Male palpal tibia and tarsus; showing dilated bulb and course of embolus and conductor.

Fig. 40. Male palpal patella, tibia, and tarsus; showing features of cymbium and paracymbium.

Chelicerae. Well developed and moderately divergent in distal halves; basal segment 1.20 mm. long; with a well developed prolateral bluntly pointed spur on each; fang regularly curved,

not sinuous; fang groove well marked; promargin of fang groove with seven teeth, retromargin with seven and with both sets spaced essentially as shown in Figure 42. There is no so-called "large tooth" on the promargin and the two most distal retromarginal teeth are close together. Some variation in number and placement of teeth has been noted among the paratypes.

Maxillae. Nearly parallel in general but slightly divergent in distal halves; with rounded distal truncatures; slightly concave along lateral surfaces; longer than lip in ratio of about 32 : 15; about three times as long as wide at narrowest level.

Lip. Broader at base than long in ratio of about 4 : 3; sternal suture gently procurved; with pronounced sternal tubercles at ends of suture.

Sternum. Generally scutiform; moderately convex; longer than wide in ratio of about 5 : 4; moderately scalloped opposite each coxa and produced between all coxae; continued as a narrow sclerite between fourth coxae which are separated by slightly more than one-third of their width.

Legs. 1243. Width of first patella at "knee" .264 mm., tibial index of first leg 5. Width of fourth patella at "knee" .198 mm., tibial index of fourth leg 7.

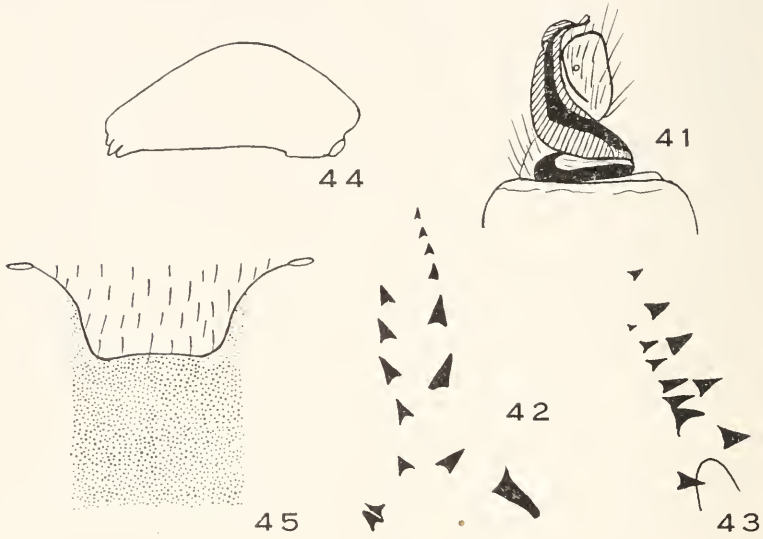
	Femora	Patellae	Tibiae	Metatarsi	Tarsi	Totals
		(All measurements in millimeters)				
1.	4.615	.910	4.205	4.745	1.170	15.695
2.	2.990	.715	2.470	2.665	.748	9.588
3.	1.365	.500	.910	1.040	.520	4.335
4.	2.795	.585	2.145	2.340	.585	8.450
Palp	.943	.325	.286	——	1.040	2.594

All legs with spines and hair. Trichobothria have been observed on all femora.

Palp. The patella is slightly longer than the tibia which has the usual distal chitinized rim. The cymbium is long, slender, constricted in the middle third, and much broader at base. The paracymbium is also slender, club-shaped, with a long chitinized border together with a chitinized knob essentially as shown in Figures 39-40. Both conductor and embolus are somewhat spiraloid, closely associated throughout their length, and with the tips extended as a terminal hook (Fig. 41). The bulb is more inflated than usual in the genus.

Abdomen. Not continued posterior to spinnerets; extended slightly over the carapace; 3.445 mm. long; slightly notched dorsally at base; about 1.235 mm. wide at widest place and, therefore, a little less than three times as long as wide; genital fold essentially as in female.

Color in alcohol. Legs and palps with varying shades of yellowish. Chelicerae brownish. Carapace yellowish with irregular inter-communicating grayish lines; just in front of



External Anatomy of *Tetragnatha*

Figures 41-45, *T. gertschi*

Fig. 41. Distal end of male palpal tarsus.
Figs. 42-43. Male and female cheliceral teeth, respectively.
Fig. 44. Lateral view of female abdomen.
Fig. 45. Genital fold of female.

thoracic pit there is a small gray elongated spot. Sternum, lip, and maxillae are brownish with fine gray dots. Abdomen: dorsum yellowish with numerous small subchitinous irregular silvery flecks; lateral sides irregularly black with larger silvery

spots; venter with a central grayish stripe and a yellowish stripe on each side with numerous silvery flecks.

Female allotype. Total length including chelicerae 5.525 mm. Carapace 1.625 mm. long; 1.235 mm. wide opposite second coxae where it is widest; otherwise essentially as in male.

Eyes. Essentially as in male.

Chelicerae. Moderately robust; moderately divergent; basal segment .845 mm. long. Fang without conspicuous features. Fang groove well marked; with five promarginal teeth and seven retromarginal teeth, spaced as shown in Figure 43.

Maxillae. Essentially parallel; broadened distally and less rounded there than in males. Otherwise essentially as in male.

Lip. Broader at base than long in ratio of 19 : 13. Otherwise essentially as in male.

Sternum. Longer than wide in ratio of 15 : 11. Otherwise essentially as in male.

Legs. 1243. Width of first patella at "knee" .242 mm., tibial index of first leg 6. Width of fourth patella at "knee" .187 mm., tibial index of fourth leg 9.

	Femora	Patellae	Tibiae	Metatarsi	Tarsi	Totals
	(All measurements in millimeters)					
1.	3.770	.780	3.510	3.640	.910	12.610
2.	2.470	.650	1.820	2.080	.660	7.680
3.	1.100	.430	.650	.910	.380	3.470
4.	2.405	.455	1.625	1.885	.575	6.945

Spines and hairs on legs as in male.

Abdomen. Conspicuously gibbous just in front of middle (Fig. 44); 3.9 mm. long; genital fold as shown in Figure 45.

Color in alcohol. Essentially as in male except that the abdomen is more conspicuously provided with the silvery flecks and has the dark lateral irregular spots much reduced; there is also a clear middorsal stripe with narrow lateral oblique lines extending ventrally as in so many species of this genus.

Type locality. Male holotype and female allotype from El Volcan, Chiriqui, R. P., August, 1950. Several paratypes of both sexes from El Volcan, August, 1950 and Boquete, Chiriqui, R. P., July, 1939 and 1954.

Tetragnatha guatemalensis O. P. Cambridge, 1889
(Figures 46-53)

T. guatemalensis F. P. Cambridge, 1903
T. guatemalensis Banks, 1909
T. guatemalensis Petrunkevitch, 1911
T. seneca Seeley, 1928
T. banksi Levi and Field, 1954
T. guatemalensis Roewer, 1942
T. guatemalensis Kraus, 1955

Male hypotype. Total length including chelicerae 13 mm.; exclusive of the chelicerae 8.10 mm. Carapace 2.925 mm. long; 1.95 mm. wide opposite second coxae where it is widest.

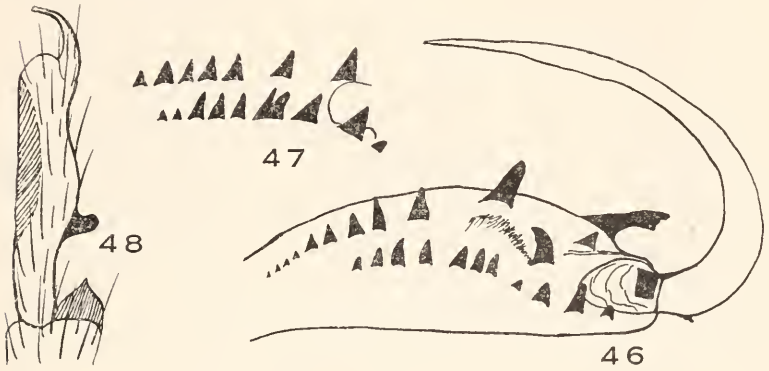
Eyes. Viewed from above, both rows recurved, anterior row rather strongly, posterior row moderately. Viewed from in front, anterior row moderately recurved, posterior row slightly procurved (Fig. 53), both measured by centers. Central ocular quadrangle wider behind than in front in ratio of 23 : 18; wider behind than long in ratio of 23 : 19. Ratio of eyes AME : ALE : PME : PLE = 6 : 4.5 : 5 : 5. AME separated from one another by their diameter, from ALE by about 2.33 times their diameter. PME separated from one another by twelve-fifths of their diameter, from PLE by 2.7 times their diameter. Laterals separated from one another by about the diameter of PLE. AME separated from PME by about 1.33 times the diameter of AME, hence further from one another than ALE are from PLE. Height of clypeus equal to 1.5 times the diameter of AME.

Chelicerae. Very divergent; basal segment slightly shorter than carapace. The following features appear to be particularly worthy of mention: there is a basal dorsal cusp on the fang but it appears to be variable in the degree to which it is developed in different individuals; the prolateral spur is robust and shows two tubercles below the apex; along the promargin of the fang groove there is a small tooth fairly close to the spur, a hook-like tooth behind that, then the "large tooth", and this is followed by a series of nine teeth with the last four being very minute (this is not in agreement with statement by F. P. Cambridge); the retromargin has three teeth near the apex, then a small tooth (not present on the right side), and this is followed by seven

teeth (Fig. 46). The spur, the three most apical promarginal teeth, and the three most apical retromarginal teeth appear to be fairly consistent in their appearance in different individuals but a considerable range of variation has been noted with respect to the remaining teeth.

Palp. Tibia longer than patella in ratio of 3 : 2; conductor geniculate at beginning of apical third, somewhat spoon-shape at apex; paracymbium terminates in a unique slender curved process (Figs. 49-51).

Female hypotype. Total length including chelicerae 10.40 mm. Abdomen considerably swollen in anterior half; genital fold as shown in Figure 52.



External Anatomy of *Tetragnatha*

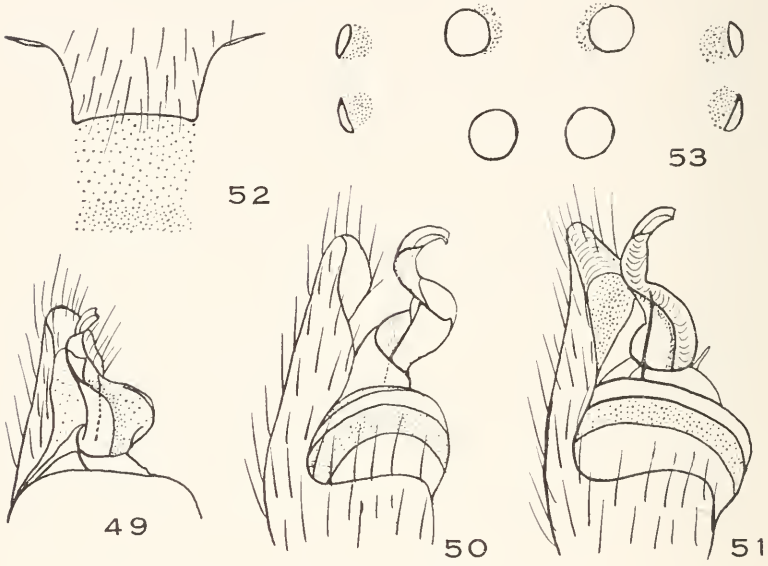
Figures 46-48, *T. guatemalensis*

Figs. 46-47. Male chelicera and cheliceral teeth, and female cheliceral teeth, respectively.
Fig. 48. Male paracymbium.

Chelicerae. The fang has a dorsal basal cusp; the promargin of the fang groove has a large apical tooth, a somewhat smaller tooth considerably separated from the first, and then after a considerable space there is a series of five teeth diminishing in size toward the proximal end of the segment; the retromargin has a small apical tooth, a large tooth close to it followed by a series of eight teeth with the second and third of this series

coalescent (Fig. 47). A considerable variation in respect to number of teeth and their placement has been noted among different individuals.

Color in alcohol. The color is difficult to describe adequately. The carapace has a pair of broad dusky dorsal stripes reaching from the median pit to the posterior eyes; the lateral sides of



External Anatomy of *Tetragnatha*

Figures 49-53, *T. guatemalensis*

Figs. 49-51. Three views of distal end of male palpal tarsus; Fig. 49 drawn at a smaller scale.
Fig. 52. Genital fold of female.
Fig. 53. Eye group of male from in front.

the carapace are also dusky. The abdomen is covered by many small irregular whitish spots; laterally there are many narrow black irregular stripes alternating with narrow yellowish stripes; the venter has the usual dark median stripe with lighter spangled areas on each side.

Type locality. The male and female hypotypes are from Barro

Colorado Island, C. Z., August, 1954. Numerous specimens of both sexes from: Barro Colorado Island, June, July, 1934; July, 1936; June, 1939; June, 1950; August, 1954; Gamboa, C. Z., July, 1954.

Tetragnatha laboriosa Hentz 1850
(Figures 54-59)

T. illinoisensis Keyserling, 1879
T. alba, F. P. Cambridge, 1903
T. alba Banks, 1909
T. alba Petrunkevitch, 1911
T. laboriosa Petrunkevitch, 1911
T. laboriosa Seeley, 1928
T. alba Roewer, 1942
T. laboriosa Roewer, 1942
T. laboriosa Kraus, 1955

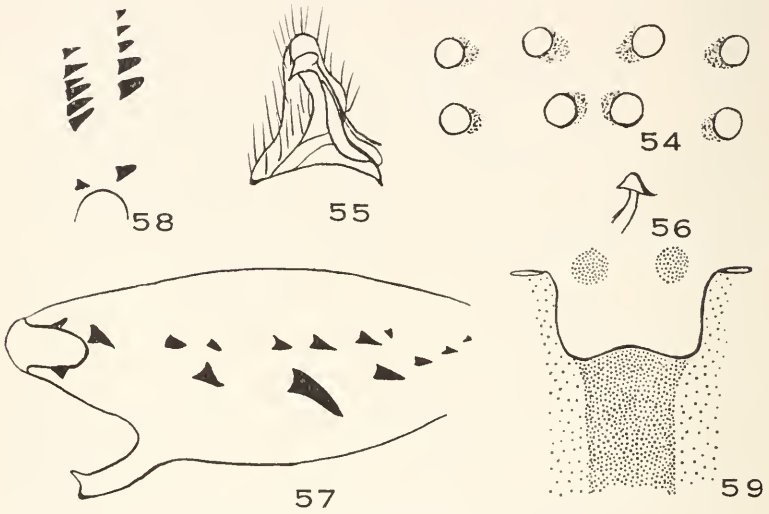
Notes from Dr. W. J. Gertsch suggested the synonymy given above. Comparisons of many specimens of both *T. laboriosa* and *T. alba* from different localities have convinced me that this is correct. Since the species has been described many times and is one of the best known in the genus only those features believed to be most distinctive will be emphasized here.

Distinctive features: Male. ALE and PLE about as far from one another as AME are from PME; palpal patella slightly shorter than palpal tibia; the conductor and embolus as shown in Figures 55-56; the paracymbium is not divided distally; the prolateral spur is robust and bifid distally; the "large tooth" is present on the promargin of the fang groove with other teeth as shown in Figure 57; the abdomen is conspicuously silvery with alternating dark and silvery stripes; of medium size, varying from 5 mm. to about 6.5 mm.

Female: size varies from about 6 mm. to about 8 mm. in length; the genital fold as shown in Figure 59; the cheliceral teeth as shown in Figure 58 with considerable variation noted among the many individuals examined; F. P. Cambridge noted a small dorsal basal cusp on the fang but I have not found this.

Collection records: Numerous specimens of both sexes from El Volcan, Chiriqui, R. P., February 28, 1936 (W. J. Gertsch), and August, 1950; Boquete, Chiriqui, R. P., August, 1954;

Chilibre, C. Z., July, 1950; apparently also from Barro Colorado Island, C. Z., June, 1934 and 1936; August, 1939; July, 1954.



External Anatomy of *Tetragnatha*

Figures 54-59, *T. laboriosa*

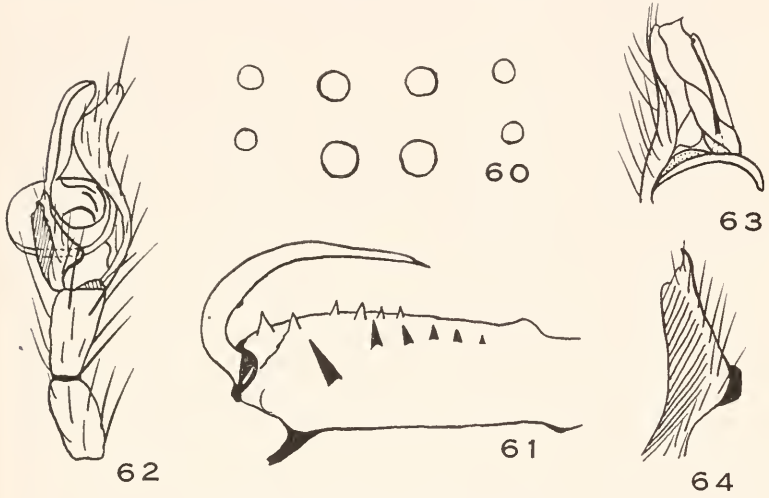
Fig. 54. Eye group of male from in front.
Fig. 55. Distal end of male tarsus.
Fig. 56. Distal end of male conductor, from a different view, to show distinctive apex.
Fig. 57. Male cheliceral teeth.
Fig. 58. Female cheliceral teeth.
Fig. 59. Genital fold of female.

Tetragnatha mabelae sp. nov.
(Figures 60-64)

Male holotype. Total length exclusive of the chelicerae 6.305 mm.; including the chelicerae 7.085 mm. Carapace 1.885 mm. long, 1.105 mm. wide opposite second coxae where it is widest; neither eye row occupies the full width of the carapace at its level.

Eyes. Eight in two rows as usual; viewed from above, anterior

row strongly and posterior row moderately recurved; viewed from in front, anterior row gently recurved, posterior row slightly recurved, all measured by centers. Central ocular quadrangle wider behind than in front in ratio of 28 : 25; wider behind than long in ratio of about 14 : 11. Ratio of eyes AME : ALE : PME : PLE = 4.5 : 2.5 : 3.75 : 3. AME separated from one another by ten-ninths of their diameter, from ALE by a little less than twice their diameter. PME separated from one another by a little less than twice their diameter, from PLE by nearly the same distance. Laterals separated from one another by twice the diameter of ALE. AME separated from PME by a little more than their diameter (Fig. 60). Height of clypeus equal to five-fourths of the diameter of AME.



External Anatomy of *Tetragnatha*

Figures 60-64, *T. mabelae*

Fig. 60. Eye group of male from in front.
Fig. 61. Male chelicera and cheliceral teeth.
Fig. 62. Male palpal patella, tibia, and tarsus.
Fig. 63. Distal ends of cymbium, conductor, and embolus of male palp.
Fig. 64. Male paracymbium.

Chelicerae. Well developed; very divergent; basal segment 1.235 mm. long and, therefore, about two-thirds as long as carapace; with a moderately well developed prolateral spur terminating in a pair of minute lobules; fang moderately slender, slightly sinuous and with a small cusp on inner margin about one-fourth from base; promargin with the "large tooth" and five others diminishing in size toward the base of the segment; retromargin with six teeth as shown in Figure 61.

Maxillae. Essentially parallel; with normal concavities on outer margins toward the tip; longer than lip in ratio of 5 : 2; about four times as long as wide at narrowest place.

Lip. Broader at base than long in ratio of 4 : 3; sternal suture straight; sternal tubercles at ends of sternal suture pronounced.

Sternum. Moderately convex; generally scutiform; longer than wide in ratio of about 4 : 3; continued between fourth coxae which are separated by about one-fourth of their width.

Legs. 1243. Width of first patella at "knee" .252 mm., tibial index of first leg 4. Width of fourth patella at "knee" .187 mm., tibial index of fourth leg 5.

	Femora	Patellae	Tibiae	Metatarsi	Tarsi	Totals
		(All measurements in milimeters)				
1.	5.785	.945	5.687	5.840	1.430	19.687
2.	3.770	.780	3.120	3.250	.975	11.895
3.	2.080	.465	1.170	1.495	.650	5.860
4.	4.160	.650	3.120	3.025	.780	11.735
Palp	.975	.340	.375	——	.845	2.535

All legs with both hairs and spines.

Palp. The tibia is only slightly longer than the patella and both are short; the paracymbium is short, broad, and has a somewhat serrate distal margin; the embolus forms a normal loop on the bulb and then extends with the rather broad conductor to its termination close to the apex of the cymbium (Figs. 62-64).

Abdomen. Not continued posterior to spinnerets; extended only slightly over the carapace; only slightly notched dorsally at base; nearly uniform in width throughout; 4.355 mm. long; .780 mm. wide near base and, therefore, nearly six times as long as wide.

Color in alcohol. Legs, mouth parts, and sternum all with

varying shades of yellowish. Carapace yellowish with a dusky stripe extending from posterior border to the median pit and then continuing forward as a pair of somewhat diverging stripes. Abdomen: dorsally and dorsolaterally covered by many yellowish silvery spangles; ventrally there are fewer of the spangles with the median area free of these and somewhat transparent.

Type locality. Male holotype from Barro Colorado Island, C. Z., July, 1954. Two paratype males from Madden Dam Forest, C. Z., July, 1950. Females unknown.

Tetragnatha mexicana Keyserling, 1865
(Figures 65-70)

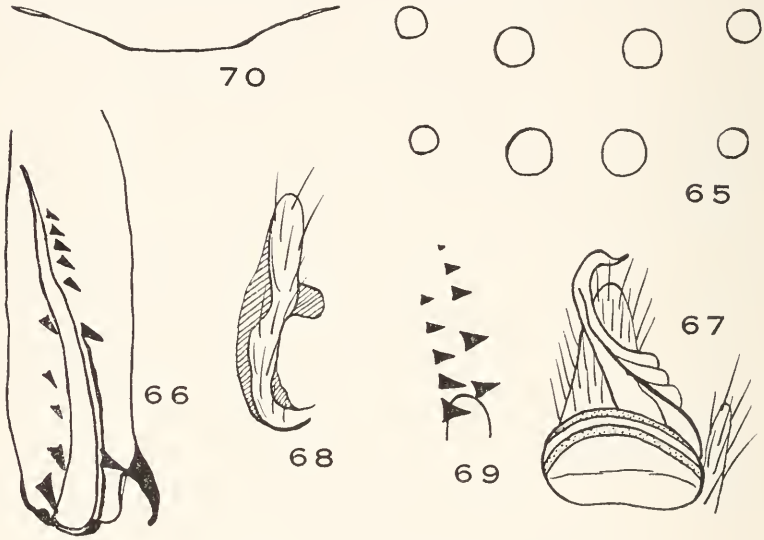
T. longa O. P. Cambridge, 1889
T. mexicana F. P. Cambridge, 1903
T. apheles Chamberlin and Ivie, 1936 (male only)
T. mexicana Roewer, 1942.

F. P. Cambridge had Keyserling's holotype female for study and regarded it as an immature specimen. He was certain that *T. longa* O. P. Cambridge was the same species and he had both sexes for study. The female reported by Banks (1929) is immature and its identification is uncertain. I have had specimens from the British Museum for comparison with mine and with those described by Chamberlin and Ivie as *T. apheles*. It is quite clear that the female of *T. apheles* is a recently moulted *T. antillana* Simon. The male appears to be a *T. mexicana* Keyserling and is so regarded here. There may be a single female in my collection which belongs to this species but I consider this uncertain. In view of the confusion relating to this species the decision has been made to give a rather complete description of a male hypotype in accord with my usual procedure.

Male hypotype. Total length including chelicerae 13.455 mm.; exclusive of the chelicerae 11.505 mm. long. Carapace 2.925 mm. long; 1.625 mm. wide opposite second coxae where it is widest; generally slender; with lateral ocular tubercles well separated; with cephalic region only slightly raised; median pit irregularly circular; with a rather marked transverse groove between AME and PME.

Eyes. Viewed from above, both rows rather strongly recurved; viewed from in front, anterior row gently recurved, posterior

row more strongly recurved, both measured by centers. Central ocular quadrangle wider behind than in front in ratio of 20 : 17; wider behind than long in ratio of 10 : 9. Ratio of eyes AME : ALE : PME : PLE = 5.5 : 3.75 : 4.25 : 4. AME separated from one another by about five-fourths of their diameter, from ALE by nearly 1.6 times their diameter. PME separated from one another by about 2.8 times their diameter, from PLE by nearly 2.25 times their diameter. Laterals separated from one



External Anatomy of *Tetragnatha*

Figures 65-70, *T. mexicana*

Fig. 65. Eye group of male from in front.
Fig. 66. Male chelicera and cheliceral teeth.
Fig. 67. Distal end of male palpal tarsus.
Fig. 68. Male paracymbium.
Fig. 69. Female cheliceral teeth from a British Museum specimen.
Fig. 70. Genital fold of female from a British Museum specimen.

another by 2.8 times the diameter of ALE. AME separated from PME by nearly 1.5 times the diameter of the former and, hence, closer to the latter than the laterals are to one another. Height of clypeus equal to a little more than twice the diameter

of AME. The relative distances between the different types of eyes as they are considered here appear to be somewhat different from those observed in specimens from the British Museum (Natural History). These differences, however, are not considered to be particularly significant.

Chelicerae. Divergent; moderately slender; basal segment 2.08 mm. long and, therefore, about two-thirds as long as carapace; prolateral spur a simple, slender hook, not bifid terminally; fang slender, somewhat sinuous; fang groove with seven promarginal teeth and five retromarginal teeth spaced essentially as shown in Figure 66. The two chelicerae do not agree in the number of teeth present along the fang groove. In the hypotype the teeth on the left are as shown in the figure while on the right there are only six promarginal teeth but there are seven retromarginal teeth. This again emphasizes the unreliability of teeth as a certain character for identification.

Maxillae. Essentially parallel but quite concave along outer margin at the beginning of the last third; considerably broadened at distal border.

Lip. Chitinized lip wider at base than long in ratio of 6 : 5; sternal suture gently procurved; with well-developed sternal tubercles at ends of sternal suture.

Sternum. Generally scutiform; longer than wide in ratio of 7 : 4; scalloped opposite all coxae and continued between all of these including the fourth which are separated by a little more than one-fifth of their width; moderately convex; covered by both relatively short and long bristles.

Legs. 1423. Width of first patella at "knee" .418 mm., tibial index of first leg 4. Width of fourth patella at "knee" .330 mm., tibial index of fourth leg 5.

	Femora	Patellae	Tibiae	Metatarsi	Tarsi	Totals
			(All measurements in millimeters)			
1.	9.945	1.300	10.595	10.725	2.145	34.710
2.	6.500	1.050	5.850	6.045	1.235	20.680
3.	3.185	.585	1.820	2.600	.845	9.035
4.	7.540	.780	6.400	5.785	1.235	21.740
Palp	1.650	.440	.660	——	.924	3.674

All legs with both spines and hairs.

Palp. The tibia is longer than the patella in ratio of 3 : 2;

the tibia has the usual chitinous rim at distal end; the paracymbium is long, rather slender, bluntly rounded at its distal end; the conductor shows three thin spiraloid plates near its middle and appears to be somewhat spiraloid at its distal end (Figs. 67-68). One specimen shows the distal end of the conductor almost exactly as drawn by F. P. Cambridge but the hypotype appears somewhat different. These differences are regarded as well within the normal variation of the species.

Abdomen. Long, slender; slightly the widest near base and gradually tapered to posterior end which is not extended beyond spinnerets; 8.385 mm. long; .975 mm. wide near base and, therefore, more than eight times as long as wide. Genital fold (Fig. 70) nearly transverse.

Color in alcohol. Legs yellowish with small grayish spots; femora one and two with an obscure prolateral grayish stripe. Chelicerae yellowish white with fang and teeth darker. Maxillae yellowish with grayish streaks. Lip yellowish with grayish markings on the strongly chitinized portions. Sternum with various shades of dusty gray. Abdomen: very light colored in general; dorsum with many irregular silvery spangles and a double series of small black dorsolateral spots; the venter has the usual median darker stripe.

Two females appear to go with the males but they are probably immature. The general characteristics of females have been studied from specimens loaned by the British Museum (Natural History). From these specimens Figures 69 and 70 have been drawn.

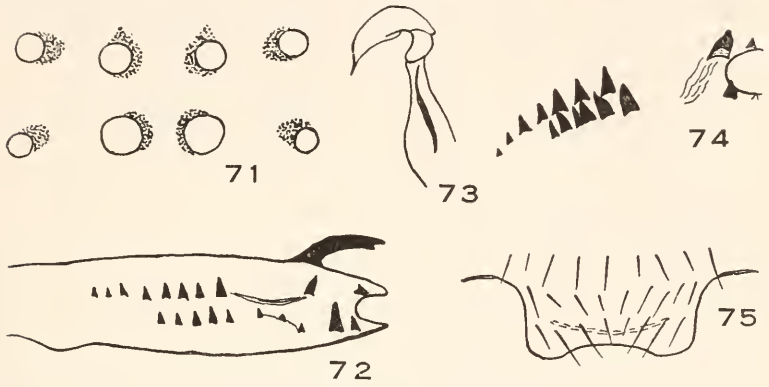
Type locality. The male hypotype is from Barro Colorado Island, C. Z., August, 1939. Three other males and probably two immature females are in the collection from the same locality, June and August, 1939.

Tetragnatha pallescens F. P. Cambridge, 1903
(Figures 71-75)

T. pallida Banks, 1892
Eugnatha pallida Banks, 1898
T. pallescens F. P. Cambridge, 1903
T. bidens F. P. Cambridge, 1903
T. pallescens Seeley, 1928

T. pallescens Petrunkevitch, 1930
T. pallescens Bryant, 1940
T. pallescens Bryant, 1945

This species is well known and has been quite adequately described by several authors in fairly recent years (Seeley, 1928; Petrunkevitch, 1930; Kaston, 1948). For this reason only distinctive characteristics and a few figures will be given in this paper. Petrunkevitch (1930) was the first, so far as I know, to point out that *T. bidens* F. P. Cambridge was the same as *T. pallescens*.



External Anatomy of *Tetragnatha*

Figures 71-75, *T. pallescens*

Fig. 71. Eye group of male from in front.
Fig. 72. Male chelicera and cheliceral teeth.
Fig. 73. Distal end of male conductor to show distinctive apex.
Fig. 74. Female cheliceral teeth.
Fig. 75. Genital fold of female.

Distinctive features. Male: The lateral eyes are considerably farther from one another than AME are from PME (Fig. 71); the palpal patella is about three-fourths as long as the palpal tibia; the conductor is curiously sickle-shaped distally (Fig. 73); the paracymbium is long, slender, and rounded at the apex; the chelicerae are nearly as long as the carapace; the prolateral spur on the basal segment of the chelicera is unequally bifid; the "large tooth" is absent from the promargin of the fang

groove; the cheliceral teeth are essentially as shown in Figure 72; in some specimens the abdomen appears to be very slightly prolonged posterior to the spinnerets; spines of moderate length are on all legs.

Female. The slightly extended abdomen is somewhat more evident in this sex than in males; the abdomen is somewhat gibbous anteriorly and is notched dorsally at its base; the cheliceral teeth are essentially as shown in Figure 74; the genital fold is essentially as shown in Figure 75.

Collection records. Both sexes have been collected in the following localities: Barro Colorado Island, C. Z., June-July, 1934; February-March, 1936 (W. J. Gertsch); June, 1936; El Volcan, Chiriqui, R. P., February, 1936 (W. J. Gertsch).

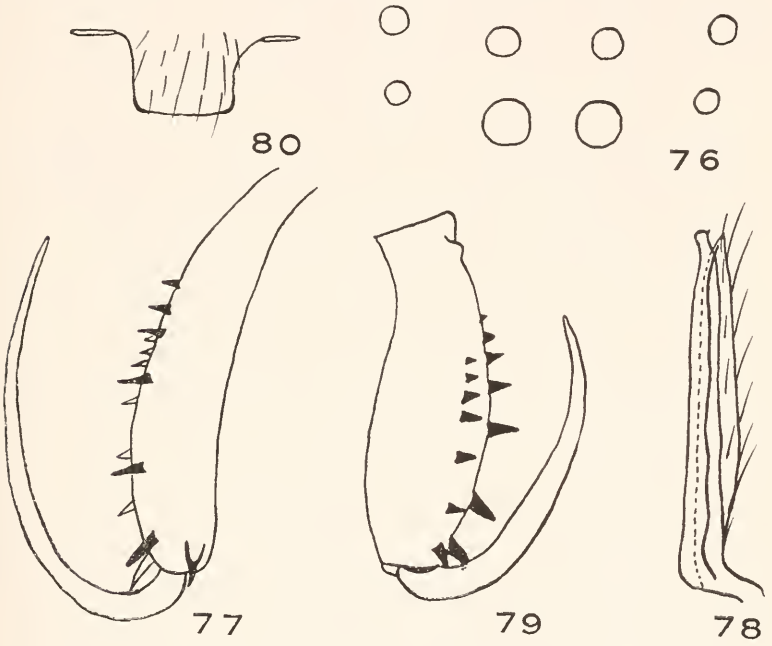
Tetragnatha pallida O. P. Cambridge, 1889
(Figures 76-80)

T. pallida F. P. Cambridge, 1903
T. pallida Banks, 1929
T. pallida Roewer, 1942

This species was described from Bugaba, Panama, and has only been reported once since that time (Banks, 1929) so far as I know.

Male hypotype. Total length exclusive of the chelicerae 6.83 mm.; including the chelicerae length is 8.455 mm. Carapace 1.755 mm. long. The whole body is long and slender. The legs are long, slender, and bear stout spines and hairs. Ratio of eyes AME : ALE : PME : PLE = 10 : 4 : 5.5 : 5.5. AME separated from one another by their diameter, from ALE by a little more than 1.5 times their diameter. PME separated from one another by slightly more than twice their diameter, from PLE by a little less than three times their diameter. Laterals separated from one another by a little less than twice the diameter of PLE (Fig. 76). AME separated from PME about as far as ALE is separated from PLE. The central ocular quadrangle is nearly square, only slightly longer than wide. Chelicerae: basal segment 1.722 mm. long and, therefore, almost as long as the carapace; the fang has no cusps; the promargin of the fang groove has six teeth and the retromargin seven, all spaced essentially as shown in Figure 77; there is no true "large tooth" in the

usual sense; the prolateral spur is simple without distal bifurcation. Palp: the tibia is longer than patella in ratio of about 3 : 2; the bulb is relatively short and the cymbium, conductor, and embolus are all long and slender (Fig. 78). The color in both sexes is very pale throughout with many yellowish silvery spangles on the abdomen. A few of the females in the collection have bright red spots at the bases of the spines and a bright red narrow dorsolateral stripe on each side of the abdomen.



External Anatomy of *Tetragnatha*

Figures 76-80, *T. pallida*

Fig. 76. Eye group of male from in front.
Fig. 77. Male chelicera and cheliceral teeth.
Fig. 78. Distal ends of male cymbium, conductor, and embolus.
Fig. 79. Female chelicera and cheliceral teeth.
Fig. 80. Genital fold of female.

Female hypotype. Total length exclusive of the chelicerae 10.01 mm.; including chelicerae 10.985 mm. Abdomen not extended posterior to spinnerets. The genital fold is shown in Figure 80. The chelicerae are relatively short and robust with seven teeth on each margin of the fang groove as shown in Figure 79.

Type locality. Male and female hypotypes from Canal Zone Forest Reserve, July, 1934. Other specimens of both sexes from Barro Colorado Island, C. Z., June-July, 1934; June-July, 1936; June-August, 1950; July-August, 1954.

Tetragnatha sinuosa sp. nov.
(Figures 81-86)

Male holotype. Total length exclusive of chelicerae 4.095 mm.; including chelicerae 4.355 mm. Carapace 1.27 mm. long, .877 mm. wide opposite intervals between second and third coxae where it is widest; anterior row of eyes occupy the full width of carapace at their level.

Eyes. Eight in two rows as usual; ocular tubercles only moderately prominent; viewed from above, both rows recurved, anterior row strongly so and posterior row moderately; viewed from in front, anterior row gently recurved, posterior row gently procurved, all measured by centers; central ocular quadrangle wider behind than in front in ratio of 14 : 11, wider behind than long in ratio of 14 : 12. Ratio of eyes AME : ALE : PME : PLE = 4 : 2.75 : 4 : 3. AME separated from one another and from ALE by nearly five-fourths of their diameter. PME separated from one another by a little more than five-fourths of their diameter, from PLE by about the same distance. Laterals separated from one another by the diameter of PLE. AME separated from PME by slightly more than their diameter, hence (Fig. 81) somewhat farther apart than laterals are separated from one another.

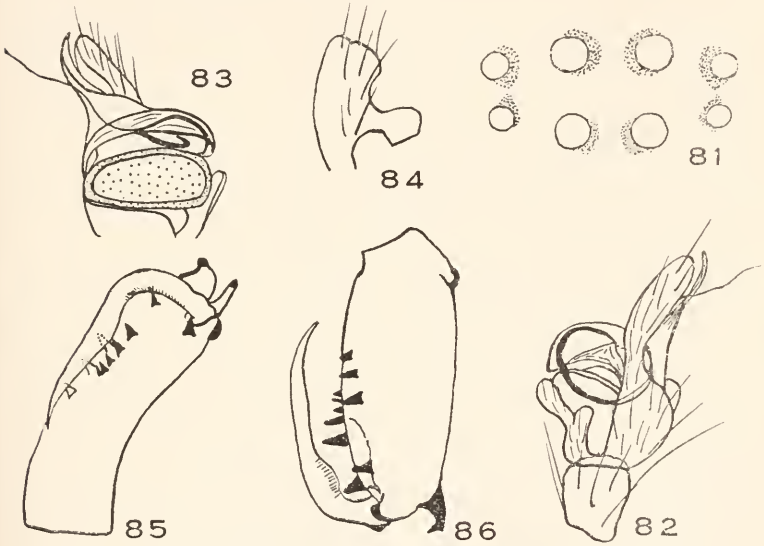
Chelicerae. Short, robust, only slightly porrect and divergent; the fang is strongly sinuous and has a low cusp on the inner surface and a low tubercle at its base on the dorsal side; the prolateral spur has moved into a nearly dorsal position; the promargin of the fang groove has five teeth with the first a massive growth not seen in any other species; the retromargin has seven

teeth (Figs. 85-86). There is no "large tooth" in the usual sense.

Maxillae. Nearly parallel with much less concavity along lateral borders than usual in the genus; longer than lip in ratio of 9 : 4; not quite three times as long as wide in the middle.

Lip. Wider at base than long in ratio of about 3 : 2; sternal suture gently procurved; sternal tubercles at ends of sternal suture shorter and blunter than usual in the genus.

Sternum. Rather strongly convex; generally scutiform; longer than wide in ratio of 7 : 5; less strongly scalloped opposite each coxa than usual in the genus; continued between fourth coxae which are separated by one-third of their width.



External Anatomy of *Tetragnatha*

Figures 81-86, *T. sinuosa*

Fig. 81. Eye group of male holotype from in front.
Fig. 82. Male palp; tibia and tarsus.
Fig. 83. Male palpal tarsus; a different view.
Fig. 84. Paracymbium of male.
Fig. 85. Male chelicera and cheliceral teeth from below.
Fig. 86. Male chelicera and cheliceral teeth; prolateral view (from a paratype).

Legs. 1423. Width of first patella at "knee" .176 mm., tibial index of first leg 4. Width of fourth patella at "knee" .132 mm., tibial index of fourth leg 7.

	Femora	Patellae	Tibiae	Metatarsi	Tarsi	Totals
		(All measurements in millimeters)				
1.	3.835	.585	3.770	3.640	1.040	12.870
2.	2.340	.520	1.950	2.080	.780	7.670
3.	1.210	.264	.704	.836	.445	3.459
4.	3.770	.330	1.650	1.950	.650	8.350
Palp	.694	.198	.210	——	.638	1.740

All legs with both spines and hair.

Palp. The tibia is slightly longer than the patella and is very broad; both tibia and patella are short; both cymbium and paracymbium appear to be somewhat distinctively shaped (Figs. 82-84); the embolus and conductor appear to be completely separated much of their lengths, the former with a conspicuous loop at the distal end of the bulb and terminating in a long lash-like apex (Figs. 82-83).

Abdomen. Not continued posterior to spinnerets; long, slender and nearly uniform in width; 3.90 mm. long, .715 mm. wide about one-third from base; not notched dorsally at base.

Color in alcohol. Generally a light yellowish throughout; the carapace is dusky gray in the cephalic portion, behind the median thoracic pit and along the lateral margins. Abdomen: the usual characteristic silvery spangles are few in number in the mid-dorsal region but are concentrated more or less as a dorsolateral stripe on each side; there is also a row of five or six darker spots above the dorsolateral silvery stripes on each side and a small median blackish spot just above the anal tubercle; the venter is almost uniformly yellowish with few yellowish silvery spangles.

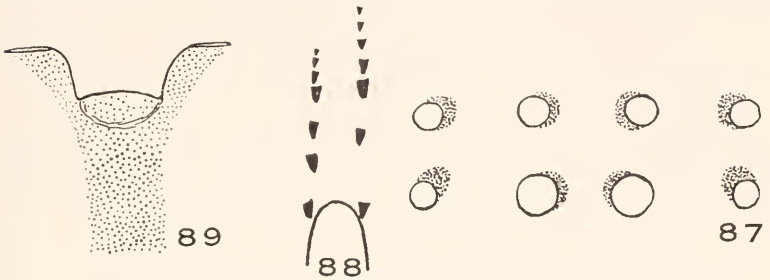
Type locality. Male holotype from Summit, C. Z., August, 1950. Four male paratypes from the same locality, August, 1950, and a single male from the C. Z. Forest Reserve, July, 1954 complete the known list of specimens. The female is unknown.

Tetragnatha tenuis O. P. Cambridge, 1889
(Figures 87-89)

T. tenuis F. P. Cambridge, 1903
T. tenuis Roewer, 1942

This seems to be a rare species in collections. The Cambridges had it from Guatemala and Panama. The British Museum (Natural History) was unable to loan me specimens and this indicated, I suppose, that only the original types are in that institution. There is one female in the M. C. Z. collection from San Domingo (Dominican Republic) doubtfully assigned to this species. As I have already pointed out, females are often difficult to identify with certainty but I seem to have a few specimens which must be assigned to this species.

Female hypotype. Total length including chelicerae 10.985 mm.; exclusive of chelicerae 9.75 mm. Carapace 2.73 mm. long, 1.625 mm. wide opposite second coxae where it is widest. The



External Anatomy of *Tetragnatha*

Figures 87-89, *T. tenuis*

Fig. 87. Eye group of female from in front.
Fig. 88. Cheliceral teeth of female.
Fig. 89. Genital fold of female.

whole body is long and slender with the abdomen only slightly swollen at base. Legs long and slender with both hairs and spines. Ratio of eyes AME : ALE : PME : PLE = 5 : 3.25 : 4.25 : 4. AME separated from one another by 1.3 times their diameter, from ALE by twice their diameter. PME separated from one another by about 2.33 times their diameter, from PLE by about 2.1 times their diameter. Laterals separated from one another by slightly less than twice the diameter of ALE. AME separated from PME by 1.2 times their diameter, hence about as far apart as ALE are from PLE (Fig. 87). Height of clypeus equal to 1.6 times the diameter of AME. The central ocular quadrangle is wider behind than in front in ratio of 17 : 14, wider behind

than long in ratio of 17 : 15. Chelicerae: robust, moderately porrect, slightly divergent; basal segment 1.55 mm. long and, therefore, only a little more than one-half as long as the carapace; fang without cusps; promargin of fang groove with seven teeth; retromargin with eight on right and seven on left (Fig. 88); teeth observed here not quite in agreement with statements made by F. P. Cambridge. Color: legs and mouth parts, except lip, with varying shades of yellowish; lip reddish brown; sternum yellowish; the carapace has a few dusky streaks behind the thoracic pit and in front of it there are two faint diverging dusky stripes passing toward the posterior eyes; on the abdomen dorsally and laterally there are many light yellowish silvery spangles surrounded by light semitransparent reticulations; the spangles diminish toward the venter and disappear medially leaving a rather narrow yellowish stripe throughout. The genital fold is shown in Figure 89.

Type locality. The female hypotype is from Barro Colorado Island, C. Z., Sept. 1939. Several other females are in my collection from the same locality, June, 1936; June and August, 1939.

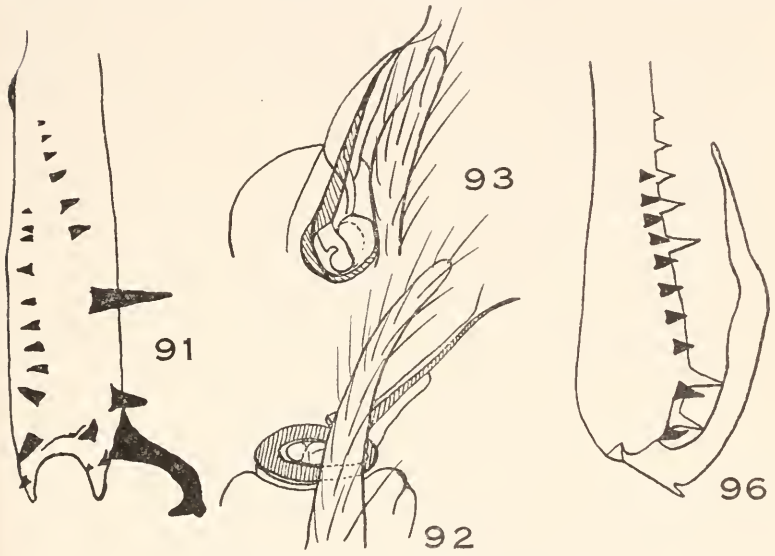
Tetragnatha tenuissima O. P. Cambridge, 1889
(Figures 90-96)

T. tenuissima F. P. Cambridge, 1903
T. tenuissima Petrunkevitch, 1925
T. tenuissima Banks, 1929
T. tenuissima Petrunkevitch, 1930
T. ethodon Chamberlin and Ivie, 1936 (Females only)
T. tenuissima Bryant, 1940
T. tenuissima Roewer, 1942
T. tenuissima Bryant, 1945

This species is now known to be widely distributed throughout Mexico, Central America, northern part of South America, and most of the Caribbean islands. Petrunkevitch (1930) described the most important features of the females. The most essential characters of both sexes will be summarized here. The species occurs in my collections most frequently of all species known from Panama.

Male hypotype. Total length including chelicerae 8.45 mm.; excluding chelicerae 7.455 mm. Carapace 2.265 mm. long, 1.04

mm. wide opposite second coxae where it is widest. Very slender throughout whole body. Head rather sharply set off from thoracic part and with nearly parallel lateral borders. Viewed from above, both rows of eyes recurved, first row strongly so; viewed from in front, anterior row moderately recurved, posterior row slightly recurved. Ratio of eyes AME : ALE : PME : PLE = 5 : 3 : 4.5 : 4. AME separated from one another by a little less than their diameter, from ALE by 1.3 times their



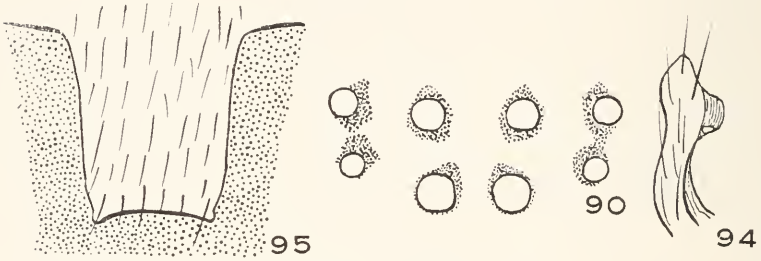
External Anatomy of *Tetragnatha*

Figures 91-93, 96, *T. tenuissima*

Fig. 91 Chelicera and cheliceral teeth of male.
Figs. 92-93. Two different views of distal end of male palpal tarsus.
Fig. 96 Chelicera and cheliceral teeth of female.

diameter. PME separated from one another by a little less than twice their diameter, from PLE by about the same distance. Lateral eyes separated from one another by the diameter of PLE. AME separated from PME by a little more than the diameter of the former and, hence, farther from one another than ALE are from PLE. The central ocular quadrangle is wider

behind than in front in ratio of about 8 : 7, slightly wider behind than long. Chelicerae: very porrect and divergent; generally long and slender; basal segment 2.21 mm. long and, therefore, almost as long as the carapace; the fang is moderately sinuous, long and slender and has no cusps; the prolateral spur is long, curved, with a very small dorsal apical tubercle and a robust ventral apical tubercle; the promargin of the fang groove has eleven teeth including the "large tooth" but the last is minute and easily overlooked; the retromargin has eleven teeth the first of which is also very small and easily overlooked (teeth as seen in the hypotype differ from those shown by F. P. Cambridge but these differences are well within the normal range of



External Anatomy of *Tetragnatha*

Figures 90, 94-95, *T. tenuissima*

Fig. 90. Eye group of male from in front.
Fig. 94. Male paracymbium.
Fig. 95. Genital fold of female.

variation). Palp: the tibia is a little shorter than the patella; the paracymbium is short, bluntly pointed at its apex and has a chitinized knob near the distal end; the conductor and embolus are finely attenuated at their tips (Figs. 92-94). One of the most distinctive features in this species is the complete absence of spines from the legs. The hair is coarse, however, and there are many bristles.

Female hypotype. Total length including chelicerae 10.725 mm.; exclusive of the chelicerae 8.775 mm. Abdomen not extended posterior to spinnerets. Also long and slender like the male but somewhat gibbous in anterior fifth of the abdomen. The

genital fold appears essentially as shown in Figure 95. Chelicerae: There is a very conspicuous basal dorsal cusp on the fang; the fang has a deep indentation on the inner side near the middle and is moderately sinuous; the promargin of the fang groove has seven teeth and the retromargin has eleven spaced essentially as shown in Figure 96 (a considerable variation in the teeth in different individuals has been noted); the basal segment is not quite as long as the carapace.

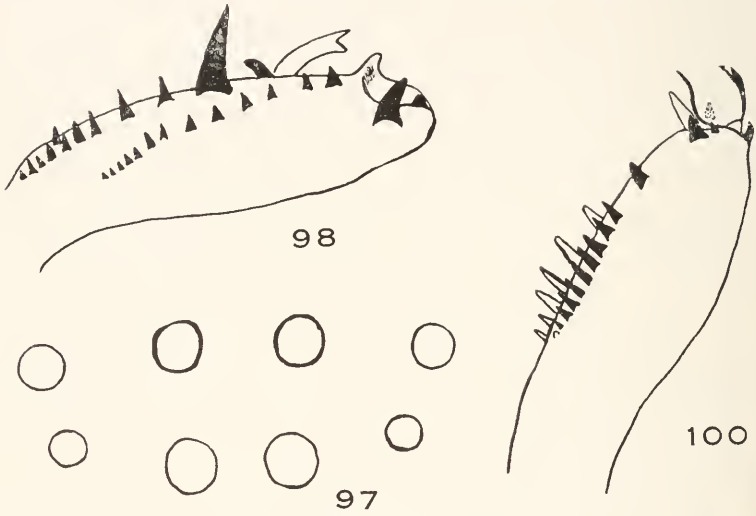
Type locality. The male hypotype is from Barro Colorado Island, C. Z., July, 1954 and the female is from the same locality, August, 1954. Many specimens of both sexes are in my collection from: Barro Colorado Island, C. Z., June-July, 1934; June-July, 1936; June-August, 1939; June-August, 1950; July-August, 1954; El Valle, R. P., July, 1936; Madden Dam, C. Z., August, 1939; C. Z. Experiment Gardens, July, July-August, 1950 and 1954; Boquete, Chiriqui, R. P., August, 1950 and 1954.

Tetragnatha tropica O. P. Cambridge, 1889
(Figures 97-102)

T. tropica F. P. Cambridge, 1903
T. tropica Banks, 1909
T. tropica Petrunkevitch, 1911
T. siduo Chamberlin and Ivie, 1936
T. amplidens Chamberlin and Ivie, 1936
T. tropica Roewer, 1942

Male hypotype. Total length including chelicerae 10.92 mm.; exclusive of the chelicerae 8.775 mm. Carapace 3.055 mm. long, 1.755 mm. wide opposite second coxae where it is widest. First row of eyes project slightly beyond the sides of the carapace; the second row occupies nearly the full width of the carapace at their level. Viewed from above, both rows of eyes recurved, posterior row slightly, anterior row moderately. Viewed from in front, anterior row moderately recurved, posterior row moderately procurved, both measured by centers (Fig. 97). Ratio of eyes AME : ALE : PME : PLE = 13 : 9 : 11 : 10. AME separated from one another by about their diameter, from ALE by about 1.5 times their diameter. PME separated from one another by nearly twice their diameter, from PLE by twice their diameter. Laterals separated from one another by slightly more

than the diameter of PLE. AME separated from PME by about 1.3 times their diameter, hence they are farther from one another than the laterals are from each other. The central ocular quadrangle is wider behind than in front in ratio of about 21 : 19, almost exactly as long as wide behind. Chelicerae: moderately porrect; strongly divergent; generally long and moderately slender; basal segment 2.86 mm. long and, therefore, only slightly



External Anatomy of *Tetragnatha*

Figures 97-98, 100, *T. tropica*

Fig. 97. Eye group of male from in front.
Fig. 98. Cheliceral teeth of male from below.
Fig. 100. Cheliceral teeth of female from below.

shorter than the carapace; the fang is slightly sinuous and has a low tubercle on the inner surface about one third of its length from the base; the prolateral spur is moderately robust and distinctly bifid apically; the promargin of the fang groove has the "large tooth" with two small teeth distal to it and a series of ten small teeth proximal to it; the retromargin has a series of fifteen teeth shaped and spaced essentially as shown in Figure 98. The last five or six teeth along the fang groove are irregular

and, apparently, quite variable among the numerous specimens available for study.

Palp. The tibia is almost twice as long as the patella; the paracymbium is bluntly pointed distally; the distal end of the conductor is subaculeate and slightly hooked (Fig. 99).

The legs have both spines and hairs some of which are quite erect.

Female hypotype. Total length exclusive of the chelicerae 10.53 mm.; inclusive of the chelicerae 13.13 mm. Abdomen not extended posterior to the spinnerets; conspicuously gibbous in anterior third and concave along dorsal surface. The genital fold is essentially as shown in Figure 102. Chelicerae: there is a dorsal basal cusp on the fang; there is also an unusual dorsal distal tooth on the basal segment of the chelicera at the base of the fang; the promargin of the fang groove has a small and a much larger tooth at the distal end and, after a considerable space, a series of seven teeth; the retromargin has a total of thirteen teeth spaced essentially as shown in Figures 100-101. The exact number of cheliceral teeth seems to be quite variable among the numerous specimens available for study. I regard Chamberlin and Ivie's *T. amplidens* as one of these with a larger number of teeth than heretofore recognized in this species. Basal segment of the chelicerae not quite as long as the carapace.

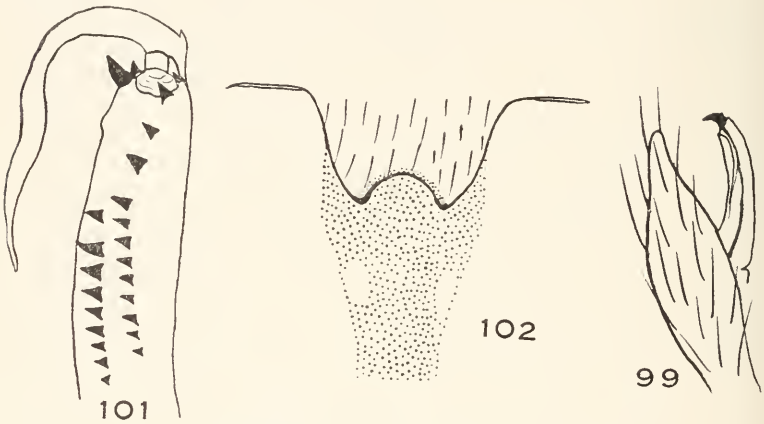
Type locality. Both hypotypes are from Barro Colorado Island, C. Z., June, 1939. Numerous specimens of both sexes are in my collection from the following localities: Barro Colorado Island, C. Z., June-July, 1934; June, 1936; June-August, 1939; June-August, 1950; July, 1954; Madden Dam Forest, C. Z., July, 1950.

Tetragnatha vermiformis Emerton, 1884
(Figures 103-108)

Eucta vermiformis Petrunkevitch, 1911
T. vermiformis Seeley, 1928
T. vermiformis Roewer, 1942.

The specimens now definitely assigned to this species have for some time been considered to represent a new and undescribed species. I have now carefully examined specimens from several parts of the United States and, together with the types in the

Museum of Comparative Zoology, compared them with my specimens from Panama. This study has convinced me that I have been dealing with the same species. There are what I consider minor differences in the cheliceral dentition, possibly the eyes and other features but I think these are all well within the normal range of variations of a widely dispersed species. It seems interesting to find this species so far south in Central America when it has previously been reported only from east of the Rocky Mountains in the United States and not yet from the West Indies.



External Anatomy of *Tetragnatha*

Figures 99, 101-102, *T. tropica*

Fig. 99. Distal ends of cymbium, embolus, and conductor of male.
Fig. 101. Cheliceral teeth of a second female from below.
Fig. 102. Genital fold of female.

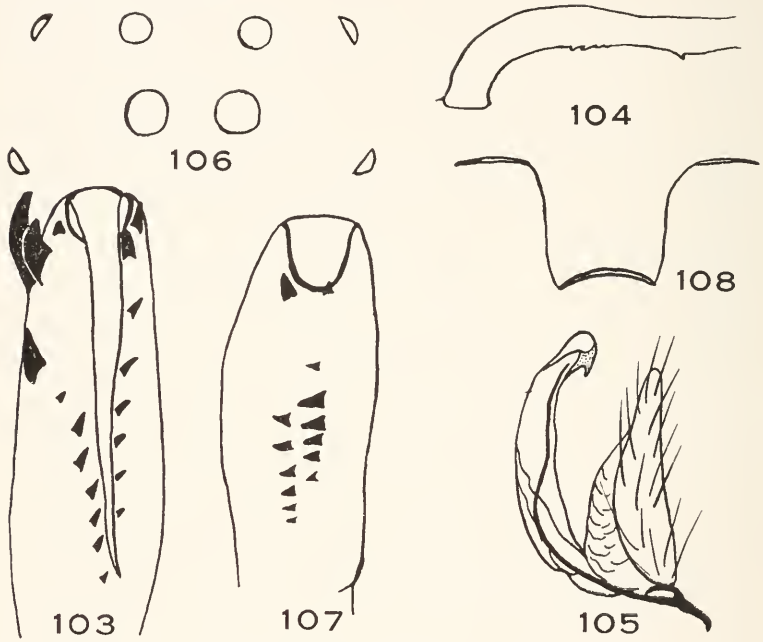
Male hypotype. Total length including the chelicerae 9.205 mm.; exclusive of the chelicerae 7.67 mm. Carapace 2.86 mm. long, 1.755 mm. wide; with anterior row of eyes occupying the full width of the carapace; with posterior row considerably shorter. Legs with both spines and hairs. Ocular tubercle bearing ALE quite prominent. Viewed from above, anterior row of eyes gently recurved, posterior row strongly recurved; viewed from in front, anterior row definitely procurved, posterior row

straight or slightly recurved. Ratio of eyes AME : ALE : PME : PLE = 5.5 : 3 : 3.5 : 3.5. AME separated from one another by about their diameter, from ALE by slightly more than twice their diameter. PME separated from one another by nearly three times their diameter, from PLE by a little more than twice their diameter. Laterals separated from one another by nearly five times the diameter of ALE. AME separated from PME by nearly twice the diameter of PME, hence much closer to one another than ALE are to PLE. The central ocular quadrangle is wider behind than in front in ratio of 17 : 15, wider behind than long in nearly the same ratio. Height of clypeus equal to twice the diameter of AME. Chelicerae: basal segment 2.47 mm. long and, therefore, about six-sevenths as long as the carapace; the fang has an inner cusp and a series of fine serrations nearer the base (Figs. 103-104); the promargin of the fang groove has ten teeth the third of which would probably be called the "large tooth" by F. P. Cambridge; the prolateral spur is slender and not apically bifid; the retromargin of the fang groove has eight teeth. Palp: the tibia, including the chitinous extension, is only slightly longer than the patella; the embolus extends in a very loose spiral through the somewhat twisted conductor to terminate in a characteristic apical form (Fig. 105); the paracymbium is broad at the base where it is strongly chitinized but it is very slender in the distal half and not notched at its apex. Color: legs, cephalothorax, and mouth parts are all yellowish; the abdomen is covered by many yellowish silvery spangles and grayish reticulations; the cardiac area has a transparent stripe; the venter is also covered by the yellowish silvery spangles and is without a median stripe which is so frequently present in the genus.

Female hypotype. Total length including the chelicerae 12.675 mm.; exclusive of the chelicerae 10.725 mm. Carapace 2.925 mm. long. Eyes essentially as in male (Fig. 106). Chelicerae: basal segment 1.95 mm. long, about two-thirds as long as carapace; the fang has no cusps; the promargin of the fang groove has seven teeth, the first of which is relatively large; the retromargin also has seven teeth, the first of which is small (Fig. 107); the cheliceral teeth are not in close agreement with description given by Seeley (1928). The genital fold is essentially as shown in

Figure 108. Abdomen: somewhat swollen at base but uniformly tapered to a blunt point at posterior end; about 4.5 times as long as wide near base; slightly extended posterior to spinnerets.

Type locality. The male hypotype and one other male are from Barro Colorado Island, C. Z., June, 1936; the female hypotype is from the same locality, August, 1939. Four females have been assigned to this species from El Volcan, Chiriqui, R. P., February, 1936 (Gertsch).



External Anatomy of *Tetragnatha*

Figures 103-108, *T. vermiformis*

Fig. 103. Male chelicera and cheliceral teeth.
Fig. 104. Lateral view of fang from male.
Fig. 105. Distal ends of cymbium, embolus, and conductor in male.
Fig. 106. Eye group of female from in front.
Fig. 107. Female cheliceral teeth.
Fig. 108. Genital fold in female.

BIBLIOGRAPHY

Banks, Nathan

1909. Arachnida from Costa Rica. Proc. Acad. Nat. Sci. Philadelphia, **61:** 194-234, pls. 5, 6.

1929. Spiders from Panama. Bull. Mus. Comp. Zool. at Harvard College, **69:** 53-96, 4 pls.

Bryant, Elizabeth B.

1940. Cuban spiders in the Museum of Comparative Zoology. *Ibid.*, **86** (7): 249-532, 22 pls.

1945. The Argiopidae of Hispaniola. *Ibid.*, **95** (4): 359-418, 4 pls.

Cambridge, O. P. and F. P. Cambridge

1889-1905. Arachnida-Araneida. Vols. I-II. *In:* Biologia Centrali-Americana. Dulau & Co., London.

Chamberlin, R. V. and Wilton Ivie

1936. New spiders from Mexico and Panama. Bull. Univ. Utah, **27** (5), Biol. Ser. **3** (5): 1-103, 17 pls.

Chickering, A. M.

1957. The Genus *Tetragnatha* (Araneae, Argiopidae) in Jamaica, B. W. I. and other neighboring islands. Breviora, Mus. Comp. Zool., **68:** 1-15.

Emerton, J. H.

1884. New England spiders of the family Epeiridae. Trans. Conn. Acad., **6:** 295-341.

Kaston, B. J.

1948. Spiders of Connecticut. Bull. Connecticut State Geol. Nat. Hist. Survey. **70:** 1-874, 144 pls.

Kraus, Otto

1955. Spinnen aus El Salvador (Arachnoidea, Araneae). Abh. Senckenberg. Naturf. Gesell., **493:** 1-112, 12 pls.

Petrunkevitch, Alexander

1911. A synonymic index-catalogue of spiders of North, Central, and South America, etc., Bull. Amer. Mus. Nat. Hist., **29:** 1-809.

1925. Arachnida from Panama. Trans. Connecticut Acad. Arts and Sci., **27:** 51-248, 157 figs.
1930. The spiders of Porto Rico. Pt. 2. *Ibid.*, **30:** 159-333, 240 figs.

ROEWER, C. FR.
1942. Katalog der Araneae. Vol. 1, 1040 pp., Bremen.

SEELEY, R. M.
1928. Revision of the spider genus *Tetragnatha*. Bull. New York State Mus., **278:** 99-150.

SIMON, EUGENE
1892- Histoire Naturelle des Araignees. Deuxième Edition. 2 Vols.
1903. Librairie Encyclopedique de Roret, Paris.

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Biological Laboratories, Harvard University

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No. 6 — *The Tenuis and Selenophora Groups of the Ant Genus Ponera (Hymenoptera: Formicidae)*

By Edward O. Wilson

When W. M. Wheeler created the new genus *Pseudocryptopone* (generitype: *Cryptopone tenuis* Emery) in 1933, it was with the free acknowledgment that this entity could not be clearly separated from *Ponera*. "Indeed, I confess my inability to draw a sharp line of demarcation between the two genera. One of the species, *incerta*, new species, which I have assigned to *Pseudocryptopone*, might, with equal propriety, be placed in *Ponera*." The purpose of this exceptional procedure was to begin a preliminary, orderly reduction of *Ponera*. "*Ponera* is now a large and very difficult genus in great need of careful revision. The monographer who undertakes this task will very probably divide it into several subgenera or even genera and his definition of these will automatically determine their relations to *Pseudocryptopone* and therefore its true status and affinities." In a similar fashion, Wheeler withdrew two Papuan species of *Ponera* (*selenophora* and *clavicornis*) and combined them with a new Philippine species (*oreas*) to form a second new genus, *Selenopone*.

Although Wheeler's aim to partition *Ponera* and thereby simplify its classification was an admirable one, the formal naming of new genera on such feeble evidence as he proposed was not well justified. A more recent examination of *Pseudocryptopone* and *Selenopone*, along with many of the related Indo-Australian species of *Ponera*, has convinced the present writer that Wheeler's genera cannot be maintained on the basis of even the most liberal criteria. To begin, *Pseudocryptopone* is linked to *Ponera* by the intermediate species *Ponera mocsaryi* Emery, which shows a combination of *Ponera* and *Pseudocryptopone* characters. These two genera are further linked by several species more closely allied to the *Pseudocryptopone* generitype, but which tend strongly toward the more typical *Ponera* type, e.g., *Ponera incerta* (Wheeler), *P. ratardorum* Wilson, and *P. huonica* Wilson. Similarly, *Selenopone* is linked to *Ponera* by the intermediate *Ponera syscena* Wilson, and is closely approached within

the ranks of the "typical" *Ponera* by the species *P. papuana* Emery. Finally, *Pseudocryptopone* and *Selenopone* are linked to one another by several more or less intermediate species, including *Ponera clavicornis* Emery, *P. tenuis* (Emery), and *P. huonica* Wilson.

In short, there does not appear at present to be any basis for a generic split along the lines proposed by Wheeler. The following synonymy is accordingly proposed:

Genus PONERA Latreille

Ponera Latreille, 1804, Nouv. Dict. Hist. Nat., 24: 178-179. Generitype: *Formica coarctata* Latreille (=*Formica contracta* Latreille), by subsequent selection.

Pseudocryptopone Wheeler, 1933, Amer. Mus. Nov., no. 672: 12-13. Generitype: *Cryptopone tenuis* Emery, original designation. NEW SYNONYMY.

Selenopone Wheeler, 1933, *ibid.*, p. 19. Generitype: *Ponera selenophora* Emery, original designation. NEW SYNONYMY.

Pseudocryptopone and *Selenopone* are of course available as subgeneric names if any reason is found to make formal subgeneric divisions in future revisions of *Ponera*. In the present study, however, the entities considered are the two *species groups* having affinities with *P. tenuis* and *P. selenophora* respectively. Both groups are herein much enlarged by the addition of a total of ten new species, most of which were collected by the author during a recent research tour in Melanesia. To the *selenophora* group have been added two older species (*scabra, sinensis*) which were apparently overlooked by Wheeler in his 1933 revision.

Together the *tenuis* and *selenophora* groups comprise a large and important section (approximately 50 per cent) of the Papuan species of *Ponera*, but the present evidence indicates that they diminish rapidly outside this area. In the *tenuis* group, a single species is known from Java and one each from the Caroline Islands, New Caledonia, and southeastern Australia. In the *selenophora* group, one species each is known from the Philippines, Hongkong, and southern Japan. It is possible that other described species from outside the Papuan region may be placed in these two groups when *Ponera* is more exhaustively studied.

At the moment the greatest concentration of species for both groups appears to exist at intermediate elevations (500-1600 meters) in the mountains of New Guinea. No less than five species, comprising 25 per cent of the total known, have been collected in a limited area around the headwaters of the Mongi River, Huon Peninsula. Further collecting in similar areas in other parts of New Guinea will probably yield a large proportion of the still undiscovered species.

The present contribution has been prepared as a preliminary part of a review of the ants of Melanesia. The remainder of the species of *Ponera* will be treated in a later part. Most of the type and other material used in this study is deposited in the Museum of Comparative Zoology at Harvard University. Other source collections have been the Emery Collection in Genoa; Dr. E. S. Ross' collection of New Guinea ants, deposited with the California Academy of Sciences; Dr. J. L. Gressitt's collection of Melanesian ants, deposited in the B. P. Bishop Museum, Honolulu; and Miss L. E. Cheesman's collection of New Hebridean ants, deposited in the British Museum of Natural History.

Measurements

In the taxonomy of a genus such as *Ponera,* where species differences are for the most part minute and subtle, exact measurements are necessary for accurate species diagnoses. In the present study an ocular micrometer was used, and estimations were made to the nearest two-tenths of a unit of 0.0293 mm, or to 0.006 mm. Thus the *calculated* maximum error is ± 0.006 mm, but in practice, of course, the *actual* maximum error varies around this figure according to the specific measurement involved. Head width, as defined below, is probably the "safest" measurement; repetitive measurements have shown that the actual maximum error is no more than ± 0.006 mm. Scape length and petiolar node length are the least reliable measurements, but even here the actual maximum error probably does not exceed four-tenths of a micrometer unit either way, or ± 0.012 mm.

Head width (HW). Worker and queen: the maximum width of the head held in perfect full face and excluding the eyes. If the eyes extend beyond the lateral borders of the head in this position, the measurement is taken across whatever parts of the

lateral borders are left exposed. *Male:* the maximum width of the head across and including the eyes.

Head length (*HL*). The length of the head, held in perfect full face, measured from the level of the anteriormost point of the anterior clypeal border to the midpoint of the occipital border.

Scape length (*SL*). The maximum length of the scape exclusive of the basal "neck."

Cephalic index (*CI*). Head width × 100/head length.

Scape index (*SI*). Scape length × 100/head width.

Pronotal width (*PW*). The maximum width of the pronotum measured from directly above and at a right angle to the long axis of the alitrunk.

Petiole height. The height of the entire petiole, measured from the level of the crest of the petiolar node to the level of the lowermost point of the subpetiolar process.

Petiolar node length. When the petiole is held in exact side view, the distance from the midpoint of the curve where the anterior face of the node meets the anterior peduncle to the midpoint of the curve where the posterior face of the node meets the posterior peduncle.

Dorsal petiole width. The width of the petiolar node measured from directly above the node and at right angles to the long axis of the body.

Characterization of the *Ponera tenuis* group

Worker. Small species, worker head width never exceeding 0.43 mm, head subrectangular, elongate, cephalic index not exceeding 86; antennal scapes short, the scape index never greater than 90; antennal club massive, 4- or 5-jointed. Mandibles with three well formed teeth occupying the apical two-fifths to one-half of the masticatory border, the remainder of the border occupied by two smaller teeth plus a number of minute intercalary denticles (*P. huonica* Wilson only) or by denticles only (other species). Eyes minute, consisting of a single ommatidium, or altogether absent; when present, located 0.7 to 0.8 the distance from the occipital border to the midpoint of the anterior clypeal border. Junction of lateral and posterior faces of the propodeum rounded, not marginate. Petiolar node relatively thick, seen

from the side, subrectangular, usually tapering very slightly dorsally; seen from directly above, its anterior face is more or less semicircular or arcuate, and its posterior face is straight to weakly concave. Subpetiolar process angular or subangular, and projecting posteriorly.

Key to the species of the *Ponera tenuis* group, based on the worker

1. Eyes absent 2
   Eyes present, although represented only by a single ommatidium and often very inconspicuous 3
2. Larger species, head width at least 0.44 mm; cephalic index at least 81; erect hairs numerous on scape, dorsum of alitrunk and entire surfaces of first two gastric tergites; antennal club indistinctly 5-jointed; body color clear yellow ..... *zwaluwenburgi* (Wheeler)
   Smaller species, head width no more than 0.30 mm; cephalic index not more than 78; erect hairs absent from scapes, alitrunk dorsum and from all but the posterior strips of the first two gastric tergites; antennal club distinctly 5-jointed; body color brownish yellow ..... *swezeyi* (Wheeler)
3. Very small species, head width not exceeding 0.31 mm; (dorsal surface of petiolar node seen from directly above, so that the posterior face is level with the line of vision, forming in its entirety distinctly more than a half-circle, its width 0.15 mm or less; body color light yellowish brown); (New Guinea) ..... *szaboi* Wilson, nom. nov.
   Larger species, head width never less than 0.32 mm and often as much as 0.38 mm or more; (dorsal surface of petiolar node seen from above varying among species, from distinctly more than semicircular to distinctly less, its width never less than 0.18 mm; color variable between species, from light yellowish brown to very dark brown) 4
4. Antennal club distinctly or indistinctly 5-jointed (see Fig. 1); (dorsal surface of petiolar node seen from directly above forming distinctly less than a half-circle) 5
   Antennal club distinctly 4-jointed; (dorsal surface of petiolar node seen from above forming in various species from distinctly less than a half-circle to distinctly more) 6
5. Body color a uniform yellowish brown; posterior border of petiolar node seen from directly above distinctly concave; (Java) ..... *incerta* (Wheeler)
   Body color a uniform dark brown; posterior border of petiolar node

seen from directly above almost perfectly straight; (New Britain to New Hebrides and Carolines) .....*ratardorum* Wilson, n. sp.

6. Smaller species, head width 0.34 mm or less; (body color clear yellow to yellowish brown) 7

Larger species, head width 0.38 mm or more; (body color varying among species, from light yellowish brown to dark brown) 8

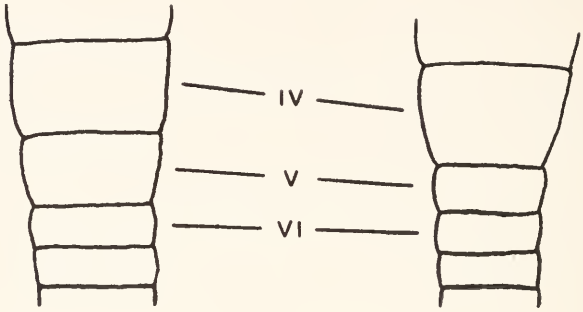

Fig. 1. Middle funicular segments in antennae of workers of two species of the *Ponera tenuis* group, showing the principal character used to divide couplet 4 of the key. Dorsal view, semidiagrammatic.

7. Lateral surfaces of alitrunk very feebly shagreened to smooth, and shining; petiolar node relatively low, its height in the unique type only 0.25 mm, or about the same as the pronotal width ....*petila* Wilson, n. sp.

Lateral surfaces of alitrunk all moderately shagreened, and opaque; petiolar node proportionately higher, its height in the single specimen measurable 0.29 mm, or slightly more than the pronotal width, which is 0.27 mm .....*szentivanyi* Wilson, n. sp.

8. Cephalic index 80 to 86; width of petiolar node not greater than 0.22 mm; medium or dark brown species from New Guinea 9

Cephalic index 71 to 76; width of petiolar node not less than 0.22 mm; light yellowish brown or light reddish brown species from New Caledonia and Australia 10

9. Dorsal surface of petiolar node seen from directly above forming distinctly more than a half-circle (see Fig. 2); posterior apex of subpetiolar process sharply truncated; slightly smaller species, head

width 0.40-0.41 mm; head dark brown, remainder of body medium brown ..... *huonica* Wilson, n. sp.

Dorsal surface of petiolar node seen from directly above forming almost an exact half-circle or very slightly less; posterior apex of subpetiolar process not truncated, but forming a full right-angle or an acute angle; slightly larger species, head width 0.42-0.44 mm; entire body uniformly dark brown ..... *tenuis* (Emery)

10. Slightly smaller species, pronotal width 0.29-0.30 mm; scape index 80-86; entire petiolar node when viewed from directly above forming almost an exact half-circle (see Fig. 2); (New Caledonia) .... *caledonica* Wilson, n. sp.

(Based on the unique worker type). Slightly larger species, pronotal width 0.32 mm; scape index 90; entire petiolar node when viewed from directly above forming distinctly more than a half-circle; (Victoria) ..... *exedra* Wilson, n. sp.

Ponera caledonica Wilson, n. sp.

Holotype worker. HW 0.40 mm, HL 0.52 mm, SL 0.32 mm, CI 77, SI 80, PW 0.30 mm, petiole height 0.31 mm, petiolar node length 0.18 mm, dorsal petiole width 0.25 mm. Mandibles with three well developed teeth occupying approximately the apical two-fifths of the masticatory border; the remainder of the border occupied by an indeterminate number of minute denticles. Eyes minute, consisting of a single ommatidium. Antennal club distinctly 4-jointed, considerably longer than the entire remainder of the funiculus. Head seen in full-face view with nearly straight sides, feebly concave occipital border. Petiolar node in side view massive, subrectangular, tapering only very slightly dorsally; seen from directly above, its dorsal surface forming an almost exact half-circle, the posterior face concave. Subpetiolar process somewhat reduced, its apex right-angular.

Dorsum of head densely punctate and subopaque to opaque; sides of head also densely punctate, but the punctures relatively shallow and the surface feebly shining. Entire dorsal and lateral surfaces of the alitrunk covered by puncturation or shagreening[1] of variable density but everywhere shallow and feeble, so that the

[1] Shagreening as most rigorously defined means "covered with small, close-set tubercles, suggesting shagreen leather," or "with a pebbled surface like shagreen leather" (Webster's International Dictionary, unabridged, second edition). In the present descriptions I have employed a somewhat broader definition of common usage in entomology, using this term to cover in addition to minute tuberculation and pebbling any dense, irregular, minute sculpturing which cannot more precisely be described as puncturation, striolation, vermiculation, or reticulation.

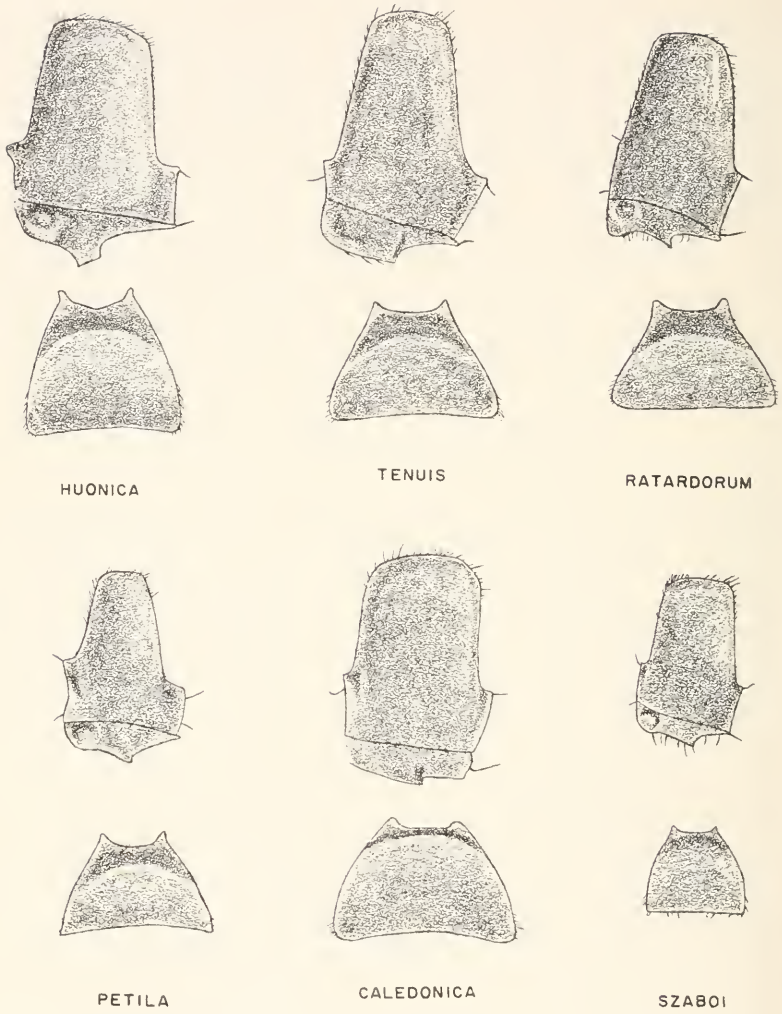

Fig. 2. Lateral and dorsal view of the worker petioles of selected species of the *Ponera tenuis* group. *Top:* left, *P. huonica* Wilson, holotype; middle, *P. tenuis* (Emery), worker from Ebabaang, New Guinea; right, *P. ratardorum* Wilson, holotype. *Bottom:* left, *P. petila* Wilson, holotype; middle, *P. caledonica* Wilson, holotype; right, *P. szaboi* Wilson, worker from the lower Busu River, New Guinea. Drawn approximately to scale.

surface varies from feebly to strongly shining. The dorsal petiolar surface and gastric tergites are also feebly sculptured and their surfaces overall feebly shining.

Body pilosity sparse, being limited almost entirely to a few hairs on the anterior clypeal border, posterodorsal border of the petiolar node, and entire surfaces of the gastric tergites. Appendages mostly bare, except for terminal surfaces of tibiae and tarsal segments. Body and appendage pubescence everywhere dense, very short and predominantly oblique to appressed.

Body concolorous yellowish ferruginous; appendages light brownish yellow to clear yellow.

Worker paratype variation. HW 0.38-0.40 mm, HL 0.51-0.52 mm, SL 0.32-0.33 mm, CI 73-76, SI 83-86, PW 0.29-0.30 mm.

Queen paratype. HW 0.41 mm, HL 0.54 mm, SL 0.36 mm, CI 76, SI 87, maximum eye length 0.09 mm, dorsal petiole width 0.26 mm. Distinguished from the worker by the usual queen-worker caste differences. As in the queens of many other species of *Ponera*, the petiolar node is much thinner than in the worker caste, forming distinctly less than a half-circle when viewed from directly above.

Relationships. P. caledonica forms with *P. exedra* Wilson of Australia a discrete subgroup of the *tenuis* group, characterized in the worker caste by relatively large size, elongated head, thick petiolar node, and light coloration. The closest affinities of the *caledonica* subgroup are evidently with the *szentivanyi* subgroup (*szentivanyi* and *petila*). *P. caledonica* can be distinguished from *P. exedra* by its smaller size, thinner node, and lighter color.

Material examined. NEW CALEDONIA: Ciu, near Mt. Canala, 300 m. (type locality), January 3, 1955, berlese sample of 12 workers and 1 dealate queen (E. O. Wilson); Mt. Mou, 180 m., December 11, 1954, 2 workers (Wilson, acc. no. 128), and berlese samples of Dec. 12 and 27, 1954, 3 workers; Chapeau Gendarme (Yahoué), Dec. 7, 1954, berlese sample of a single worker (Wilson).

Ecological note. This is apparently a rather scarce cryptobiotic species in New Caledonia. Despite rather intensive hand collecting by the author in the localities cited above, only once (acc. no. 128) was it encountered directly. In this case two workers were found with a small amount of brood in a small cavity in the

undersurface of a rock set deeply in the soil. These individuals were rather sluggish, and when prodded with the tip of a pair of forceps, rolled up and feigned death for a short while, a behavioral response common in other species of *Ponera*. All of the other collections of *caledonica* were made by filtering the ants from masses of leaf litter and soil in a Berlese funnel. The collections at Mt. Mou and Chapeau Gendarme were made in relatively dry, semi-deciduous, valley-pocket forests, while that at Ciu was in moister tropical evergreen forest.

Ponera exedra Wilson, n. sp.

Holotype worker. HW 0.38 mm, HL 0.54 mm, SL 0.34 mm, CI 71, SI 90, PW 0.32 mm, petiole height 0.30 mm, petiolar node length 0.20 mm, dorsal petiole width 0.24 mm. This species is very close to *P. caledonica* Wilson, and is distinguished by its slightly larger size, more elongate head, and longer scapes, as indicated in the measurements cited above. It also has a distinctly thicker petiolar node; when viewed from directly above, the entire surface of the node forms slightly but distinctly more than a half-circle. In addition, the subpetiolar process is somewhat more reduced, and its apical angle is obtuse.

Queen paratype. (Tentative determination). HW 0.40 mm, HL 0.54 mm, SL 0.35 mm, CI 74, SI 88, petiolar node length 0.21 mm, dorsal petiole width 0.25 mm. Distinguished from the worker by the usual queen-worker caste differences. Maximum eye length 0.11 mm. Petiolar node thinner and more sharply tapering than in worker; seen from directly above, the dorsal surface of the node alone forms distinctly less than a half-circle, but the entire node forms distinctly more. Head (except mandibles) and first three gastric tergites medium brown; alitrunk and petiole somewhat lighter yellowish brown; mandibles and appendages brownish yellow to clear yellow.

Relationships. See under *P. caledonica.*

Material examined. VICTORIA: Arthurs Seat (mountain) at McCrae, 100-300 m. (type locality); April 28, 1951; a single worker (W. L. Brown). NEW SOUTH WALES: Pymble; October 23, 1950; a single dealate queen (Brown).

Ecological notes. Dr. Brown has supplied me with the following information relative to the Arthurs Seat worker. This speci-

men was found under a rock in granitic soil in a medium rainfall forest of *Eucalyptis viminalis, E. radiata* and *Banksia* sp. Brown notes that the ant fauna of Arthurs Seat is unusual for this part of Victoria, containing a number of distinctly northern elements, e. g. *Mayriella abstinens* Forel and *Camponotus intrepidus* (Kirby). Thus the discovery of the *Ponera exedra* queen at Pymble, N. S. W., hundreds of miles to the north, is not too surprising. This latter specimen was collected from beneath a rock in medium, dry sclerophyll forest on sandstone.

The close affinities of *P. exedra* to *P. caledonica* are of considerable interest, insomuch as they represent another of a growing series of known links at the species–group level between the ant faunas of New Caledonia and eastern Australia.

Ponera huonica Wilson, n. sp.

Holotype worker. HW 0.41 mm, HL 0.49 mm, SL 0.33 mm, CI 84, SI 81, petiole height 0.33 mm, petiolar node length 0.18 mm, dorsal petiole width 0.22 mm. Right mandible with three teeth occupying the apical half of the masticatory border, a smaller tooth situated approximately midway between the basalmost of the apical teeth and the basal angle, and an even smaller, barely distinguishable tooth on the basal angle. There are no intercalary denticles evident at magnifications up to 100X; higher magnifications were not used. The left mandible is similar, but the median tooth described above is smaller and rudimentary. Eye minute, consisting of a single ommatidium. Antennal club massive, distinctly 4-jointed, slightly longer than the remainder of the funiculus. Head shape about as described in *P. szaboi* Wilson. Petiolar node seen from the side relatively thick, subrectangular, tapering very little dorsally; seen from above its dorsal surface forms slightly more than a half-circle. Subpetiolar process well-developed, its apex sharply truncated.

Mandibles smooth and shining; clypeus somewhat less smooth, and feebly shining; remainder of head roughly shagreened and opaque. Pro- and mesonotum shagreened to contiguously punctate, and subopaque; episternum and various propodeal surfaces variably punctate and feebly shining to subopaque. Petiolar node mostly covered with scattered shallow punctures, feebly to

strongly shining. Gastric tergites contiguously punctate and subopaque.

Pilosity as in *P. caledonica* but in addition with a few short erect hairs on the occipital border, anterior pronotal angle, and anterior gastric tergital surfaces. Pubescence dense, short, predominantly oblique to appressed.

Head (except mandibles) medium brown; alitrunk, petiole, and gaster light brown, the gaster a shade darker than the rest; mandibles and appendages light brown.

Worker paratype variation. HW 0.40-0.41 mm, HL 0.48-0.50 mm, SL 0.33-0.35 mm, CI 80-83, SI 81-87, PW 0.29-0.32 mm. The unusual mandibular dentition described for the holotype occurs in most of the paratype workers. In several it is modified by the addition of one or two smaller intercalary teeth or denticles on the basal half of the masticatory border. In several others the two principal teeth of the basal half are reduced to the size of normal (for the *tenuis* group) denticles.

Queen paratypes. HW 0.43-0.45 mm, HL 0.51 mm, SL 0.35-0.36 mm, CI 84-86, SI 80-82, dorsal petiole width 0.23-0.24 mm. Differing from the worker caste by the usual queen-worker differences. Compound eyes well developed, at least 0.29 mm in maximum length. Petiolar node notably more slender in side view; seen from above its dorsal surface forms distinctly less than a half-circle. Coloration similar to that of worker.

Male paratype. HW 0.43 mm, HL 0.45 mm, maximum eye length 0.21 mm, dorsal petiole width 0.14 mm. Not differing fundamentally in morphology from known *Ponera* males outside the *tenuis* group. Antennae 13-jointed. Mandibles much reduced, only about 0.06 mm in length, edentate, with rounded apices. Petiolar node seen from the side forming roughly an isosceles triangle, with slightly concave anterior and posterior faces and rounded dorsal crest; seen from above, circular in outline. Genitalia exserted. Parameres small, 0.14 mm in length (measured from distalmost edge of basiparamere to tip of paramere), tapering distally to a pointed apex. Penis valves large, prominent, extending nearly 0.1 mm beyond the dorsal margin of the parameres, their dorsal borders strongly convex, almost semicircular.

Entire body covered with abundant, relatively short (length

never exceeding 0.06 mm) oblique to erect hairs, which merge into the equally abundant underlying oblique pubescence. Appendages almost entirely lacking pilosity, supplied instead with dense, predominantly oblique pubescence.

Body uniformly dark brown; appendages light to medium brown; wings lightly and uniformly infumated.

Relationships. This species is closely allied to *P. tenuis* (Emery) and *P. ratardorum* Wilson (*q.v.*).

Material examined. P. huonica has thus far been collected only in a limited area in the mountainous region around the headwaters of the Mongi River, Huon Peninsula, northeast New Guinea. N-E NEW GUINEA: Ebabaang (type locality), 1300-1400 meters, April 16-18, 1955, 3 workers (E. O. Wilson, acc. no. 826) and nest series with 2 workers, 2 alate queens, and a male (acc. no. 827); Gemeheng, 1300-1500 m., April 11-13, 1955, worker, alate queen, dealate queen (Wilson, acc. no. 791); Joangeng, 1500 m., April 7-8, 1955, stray dealate queen (Wilson, acc. no. 746).

Ecological notes. Colonies taken at Ebabaang and Gemeheng were both small, containing probably less than 30 workers. The one at Ebabaang was found under the moss layer covering the upper surface of a large, soft, "rich-red" log. The Gemeheng colony was in a small log in the same stage of decomposition. At all localities the species was found in partly open areas at the edge of native trails running through dense, wet midmountain rainforest.

Ponera incerta (Wheeler)

Pseudocryptopone incerta Wheeler, 1933, Amer. Mus. Nov., no. 672: 18-19, fig. 7, worker, queen. Type locality: Depok, Java.

The head of the unique worker type is now unfortunately missing, so that exact measurements of cephalic and antennal proportions could not be taken. In the present diagnosis cephalic characters are taken from Wheeler's original description.

PW 0.29 mm, petiole height 0.29 mm, petiole node length 0.15 mm, dorsal petiole width 0.22 mm. Mandibles with three apical teeth, behind which the masticatory border is "finely and indistinctly crenulate" (denticulate?). Antennal club 5-jointed. Petiolar node seen from directly above forming dis-

tinctly less than a half-circle, with a shallowly concave posterior border. Subpetiolar process well developed, its apical angle acute.

Body sculpturing approximately as in *P. huonica* Wilson (*q.v.*)

Body pilosity pattern as in *P. caledonica* Wilson. Pubescence dense, short, predominantly appressed.

Body color uniformly yellowish ferruginous; legs clear yellow.

Relationships. This species is probably most closely related to *P. ratardorum* Wilson, from which it can be distinguished by slight differences in the antennal club composition and in petiolar node shape, and by a strong color difference. It bears a close habitus resemblance to *P. szaboi,* but can be easily distinguished from that species by its 5-jointed antennal club, thinner petiolar node, and somewhat more strongly shagreened alitruncal dorsum.

Material examined. JAVA: Depok, worker holotype.

Ponera petila Wilson, n. sp.

Holotype worker. HW 0.32 mm, HL 0.41 mm, SL 0.28 mm, CI 78, SI 88, PW 0.25 mm, petiolar height 0.25 mm, petiolar node length 0.13 mm, dorsal petiole width 0.18 mm. Very similar to *P. szentivanyi* Wilson, differing slightly in body and appendage proportions as given in the measurements cited above, and in the much feebler body sculpturing, which can be described as follows. Sides of head densely but shallowly punctate, and feebly shining. Entire dorsal and lateral surfaces of the alitrunk with puncturation or shagreening of variable density but everywhere shallow and feeble, so that the surface is feebly to strongly shining. The gastric tergites are also more feebly sculptured than in *szentivanyi* and their surfaces overall feebly shining.

Relationships. Closely resembling *P. szentivanyi* Wilson, as detailed in the comparative description of that species to follow.

Material examined. N-E. NEW GUINEA: lower Busu River, near Lae; May 10, 1955; a single worker (Wilson, acc. no. 999).

Ecological note. The single worker was collected as a stray in the superficial layers of soil beneath a rotting log on the ground in primary lowland rainforest.

PONERA RATARDORUM Wilson, n. sp.

Holotype worker. HW 0.37 mm, HL 0.47 mm, SL 0.31 mm, CI 79, SI 84, PW 0.29 mm, petiole height 0.28 mm, petiolar node length 0.15 mm, dorsal petiole width 0.20 mm. Mandibles with three well developed teeth occupying about the apical two-fifths of the masticatory border; the remainder of the border occupied by a series of minute denticles. Eye minute, consisting of a single ommatidium, located approximately 0.8 the distance from the lateral occipital border to the midpoint of the anterior genal border. Antennal club massive, indistinctly 5-jointed. Petiolar node seen from side subrectangular, tapering almost imperceptibly dorsally, the dorsal surface feebly convex; the dorsal surface seen from directly above forms distinctly less than a half-circle, and the posterior nodal border is almost perfectly straight. Subpetiolar process well developed, its apical angle acute.

Sculpturing very similar to that described for *P. huonica.*

Pilosity and pubescence as described for *P. caledonica.* Body medium brown, the head and gaster a shade darker than the alitrunk and petiole. Appendages clear yellow.

Worker paratype variation. New Britain and New Hebrides: HW 0.36-0.38 mm, HL 0.46-0.48 mm, SL 0.30-0.32 mm, CI 78-80, SI 83-86, PW 0.27-0.30 mm. Carolines: HW 0.38 mm, HL 0.49 mm, SL 0.33 mm, CI 88, SI 87, PW 0.29 mm.

Relationships. This species most closely resembles *P. incerta* (Wheeler) of Java, differing in its darker color, distinctly 5-jointed antennal club (versus indistinctly 5-jointed in *incerta*), and straight posterior face of petiolar node. Superficially *P. ratardorum* resembles *P. huonica* Wilson and *P. tenuis* (Emery) but can be readily distinguished from these two species by its 5-jointed antennal club and much thinner petiolar node.

Material examined. NEW BRITAIN: St. Paul's, Baining Mts., Gazelle Peninsula, 350 m. (type locality); Sept. 5, 1955; holotype and three paratype workers (J. L. Gressitt). NEW HEBRIDES: Ratard Plantation, 8 km. southwest of Luganville, Espiritu Santo; Jan. 7-13, 1955; two paratype workers (Wilson, acc. no. 348). CAROLINES: Yap I., one paratype worker (R. J. Goss). The holotype and two paratypes have been returned to the Bishop Museum, Honolulu; the four remaining paratypes have

been deposited in the Museum of Comparative Zoology and U. S. National Museum.

This species is named in honor of Aubert and Suzanne Ratard, of Noumea and Luganville, the writer's gracious hosts during his brief stay in the New Hebrides.

Ecological notes. Dr. Gressitt's New Britain specimens were taken from a rainforest humus berlesate. The present writer's New Hebrides specimens were found foraging during the day in leaf litter on the floor of primary coastal rainforest.

Ponera swezeyi (Wheeler)

Pseudocryptopone swezeyi Wheeler, 1933, Amer. Mus. Nov., no. 672: 16-17, fig. 6, worker, queen. Type locality: vicinity of Honolulu, Hawaii.

The following measurements and descriptive notes are based on three worker syntypes in the Museum of Comparative Zoology.

HW 0.29-0.30 mm, HL 0.38-0.41 mm, SL 0.25-0.26 mm, CI 72-78, SI 84-85, PW 0.21-0.24 mm, petiole height (single measurement) 0.24 mm, dorsal petiole width 0.18 mm. Mandible with three distinct apical teeth occupying slightly less than half the masticatory border; the remainder of the border bearing an indeterminate number of minute denticles. Antennal club distinctly 5-jointed. Petiolar node seen from directly above forming slightly more than a half-circle. Subpetiolar process well developed, its apex right-angular.

Sculpturing about as in *P. caledonica* except that on the alitrunk only the declivitous faces of the propodeum are smooth and shining, the remainder of the alitruncal surfaces being lightly shagreened and only feebly shining.

Body concolorous light brownish yellow; appendages clear yellow.

Relationships. This distinctive little species does not appear to be closely related to any of the other known members of the *tenuis* group.

Material examined. HAWAII: vicinity of Honolulu, 3 syntype workers (R. H. Van Zwaluwenburg); Herring Valley, Honolulu (F. X. Williams).

Note on distribution. This species is known only from material collected in the vicinity of Honolulu. The habitat of the type series, "soil of cultivated and fallow sugar-cane fields," suggests

that it may have been introduced by man into the Hawaiian Islands. Future collecting may show that its native range lies somewhere in the "source areas" of Melanesia or the East Indies.

Ponera szaboi Wilson, nom. nov.

Cryptopone mocsáryi Szabó, 1910, Rovartani Lap., 17: 186, fig. 1, worker. Secondary homonymy by present assignment to *Ponera* (nec *Ponera mocsaryi* Emery, 1900). Type locality: Friedrich-Wilhelmshafen (=Madang), N-E. New Guinea.

Pseudocryptopone mocsaryi, Wheeler, 1933, Amer. Mus. Nov., no. 672:14.

The description offered below is based on two workers collected by myself in the vicinity of the lower Busu River, N-E. New Guinea. These correspond well to Szabó's description and figure, differing only in having somewhat more elongate heads than shown by Szabó.

HW 0.30-0.31 mm; HL 0.40 mm; SL 0.25 mm; CI 76-78; SI 79-83; PW 0.23 mm; petiole height (single measurement) 0.24 mm; petiolar node length 0.15 mm; dorsal petiole width (single measurement) 0.15 mm. Mandible linear-subtriangular. The apical half of the masticatory border occupied by three distinct, acute teeth; the basal half occupied by an indeterminate number of minute denticles. Eyes minute, consisting of a single ommatidium. Antennal club massive, distinctly 4-jointed, considerably longer than the entire remainder of the funiculus. Head in full-face view subrectangular, with very feebly convex sides and feebly concave posterior border. Petiolar node seen from the side relatively thick, tapering slightly dorsally, with a feebly convex dorsal border; seen from directly above, with the posterior face aligned with the plane of vision, the node forms distinctly more than a half-circle, and the posterior border appears almost perfectly straight. Subpetiolar process well-developed, its apical angle obtuse.

Mandibles smooth and shining; clypeus smooth and feebly shining; remainder of head finely and evenly shagreened and subopaque. All of alitruncal surfaces finely shagreened and subopaque, except the episterna and declivitous faces of the propodeum, which bear only scattered fine punctures and are relatively smooth and more or less shining. Various surfaces of the petiolar node bearing variably dense but fine and separated

punctures, and otherwise smooth and more or less shining. Gastric tergital surfaces shagreened and subopaque, except for the anterior declivity of the first gastric tergite, which is smoother and feebly shining.

Pilosity and pubescence as described for *P. caledonica* Wilson.

Alitrunk and petiole yellowish brown; head and gaster somewhat darker, approaching medium brown; appendages nearly clear yellow.

Relationships. In its distinctive combination of characters in size, petiole form, and body color, *szaboi* stands well apart from all the other known species of the *tenuis* group.

Material examined. N-E. NEW GUINEA: lower Busu River, near Lae, 2 workers (Wilson, acc. nos. 963, 1024).

Ecological note. Both of the Busu River specimens were taken as strays on the floor of primary lowland rainforest.

Ponera szentivanyi Wilson, n. sp.

Holotype worker. HW 0.34 mm; HL 0.45 mm, SL 0.32 mm, CI 76, SI 94, PW 0.28 mm (petiole height not measured; see paratype), petiolar node length 0.16 mm, dorsal petiole width 0.24 mm. Three well developed teeth occupying the apical two-fifths of the masticatory border, followed basally by an indeterminate number of minute denticles. Eye minute, consisting of a single ommatidium, located about 0.8 the distance from the lateral occipital border to the midpoint of the anterior genal border. Antennal club distinctly 4-jointed, considerably longer than the remainder of the funiculus. Head elongate (CI 76) with very feebly convex sides, and feebly but distinctly concave occipital border. Petiolar node seen from side relatively thin, elongate-trapezoidal; seen from directly above, so that the posterior face is exactly parallel with the line of vision, the node as a whole forms slightly more than a half-circle, but the dorsal surface alone forms much less than a half-circle; seen from the preceding position the posterior face is feebly but distinctly concave. Subpetiolar process somewhat reduced, its apex right-angular.

Body sculpturing approximately as described for *P. huonica* Wilson.

Pilosity and pubescence as in *P. caledonica* Wilson.

Body uniformly light brownish yellow; appendages clear yellow.

Paratype worker. A single callow worker taken with the holotype has the integument of the head somewhat crumpled and distorted through drying, so that regular cephalic measurements could not be made. PW 0.28 mm, petiole height 0.29 mm, dorsal petiole width 0.21 mm. Body color clear, pale yellow.

Relationships. This species most closely resembles *P. petila* Wilson, as indicated under the comparative description of that species. Together *szentivanyi* and *petila* form a subgroup of their own within the *tenuis* group, characterized in the worker caste by intermediate size, slender body form with elongate head, thin petiolar node, and brownish yellow body color. They are closest to the subgroup formed by *P. caledonica* Wilson and *P. exedra* Wilson, from which they can be distinguished by their smaller size and thinner petiolar node.

Material examined. PAPUA: Karema, near the Brown River, about 30 miles north of Port Moresby; March 8-11, 1955; holotype and single paratype worker (Wilson, acc. no. 563). This species is named in honor of Dr. J. H. Szent-Ivany, the expert resident entomologist of the Territory of Papua-New Guinea, whose friendly assistance greatly aided the author's field work in this area.

Ecological note. The two type workers were taken close together on the floor of primary lowland rainforest.

Ponera tenuis (Emery)

Cryptopone tenuis Emery, 1900, Természetr. Füz., 23: 321-322, pl. 8, figs. 21, 22, worker. Original localities: Lemien, near Berlinhafen (=Aitape), and Tamara I., N-E. New Guinea.

Pseudocryptopone tenuis, Wheeler, 1933, Amer. Mus. Nov., no. 672: 13-14.

Lectotype worker.[1] HW 0.44 mm, HL 0.52 mm, SL 0.35 mm, CI 85, SI 80, PW 0.32 mm, petiole height 0.32 mm, petiolar node length 0.17 mm, dorsal petiole width 0.22 mm. Right mandible with three[2] rather worn, indistinct teeth occupying the apical half of the masticatory border; followed by an indeterminate number of minute, blunt denticles occupying the basal half of

[1] By present selection, a syntype worker in the Emery Collection, kindly loaned to the author by Dott. Delfa Guiglia.

[2] Not four as stated by Emery in the original description.

the border. Eyes minute, consisting of a single ommatidium. Antennal club massive, distinctly 4-jointed, considerably longer than the remainder of the funiculus. Petiolar node seen from the side subtrapezoidal, tapering slightly dorsally, with a convex dorsal margin, its dorsal surface seen from directly above forming almost exactly a half-circle or very slightly less. Anterior half of subpetiolar process perforated by a small, median hole; the posterior apex of the process forming an acute angle.

Sculpturing as described for *P. huonica* Wilson.

Pilosity and pubescence as described for *P. huonica,* except that erect hairs are lacking from the occiput and pronotum; these missing hairs may well have been rubbed off in this specimen, because they are present in more recently collected material determined as *tenuis.*

Body uniformly yellowish brown, appendages clear yellow (specimen possibly faded; see below).

Variation in other worker series. The following measurements are based on three workers from a single nest series collected at Ebabaang: HW 0.42-0.43 mm, HL 0.49-0.52 mm, SL 0.33-0.35 mm, CI 82-86, SI 78-83, PW 0.32 mm. In these specimens the anterior half of the subpetiolar process is not perforated as in the lectotype, and the posterior angle of the process forms a right angle instead of an acute angle. The body color is uniformly blackish brown, and the appendage color is light yellowish brown; there is an excellent possibility that the considerably lighter color of the lectotype is due to fading.

Queen (tentative determination). HW 0.50 mm, HL 0.58 mm, SL 0.40 mm, CI 86, SI 80, dorsal petiole width 0.27 mm. Differing from the worker by the usual formicid queen-worker differences. Maximum eye length 0.15 mm. Petiolar node much thinner than in worker, seen from directly above forming much less than a half-circle. Distinguished from the queen of *P. huonica* by its larger size, darker body color (uniformly blackish brown as opposed to predominantly medium brown in *huonica*), and somewhat thinner petiolar node.

Relationships. P. tenuis most closely resembles *P. huonica* Wilson, from which it differs principally in its more conventional mandibular dentition, thinner petiolar node, differently shaped subpetiolar process, and darker body color. Together these two species bear a close habitus resemblance to *P. clavicornis* Emery,

and may in fact provide a link between the *tenuis* and *selenophora* species groups.

Material examined. N-E. NEW GUINEA: (Lemien or Tamara I.), lectotype worker; Ebabaang, Mongi River Watershed, 1300-1400 m., 3 workers (Wilson, acc. no. 828); Joangeng, near Ebabaang, 1500 m., a stray dealate queen (Wilson, acc. no. 746).

Ecological note. The Ebabaang workers were found foraging during the day in leaf litter on the floor of midmountain rainforest.

Ponera zwaluwenburgi (Wheeler)

Pseudocryptoponc zwaluwenburgi Wheeler, 1933, Amer. Mus. Nov., no. 672: 14-16, fig. 5, worker. Type locality: Oahu Island, Hawaii (by present selection).

The following measurements and descriptive notes are based on four worker syntypes in the Museum of Comparative Zoology.

HW 0.44-0.47 mm, HL 0.53-0.59 mm, SL 0.38-0.42 mm, CI 81-84, SI 87-88, PW 0.32-0.35 mm, petiole height (single measurement) 0.28 mm, dorsal petiole width 0.20-0.23 mm. Mandibles with three well developed teeth occupying less than half the masticatory border, the remainder being occupied by an indeterminate number of minute denticles. Antennal club indistinctly 5-jointed. Petiolar node seen from directly above forming distinctly more than a half-circle. Subpetiolar process reduced to a mere convexity.

Entire body finely and densely shagreened and subopaque, except the mandibles, posterior face of the propodeum, and posterior face of the petiolar node, which are relatively smooth and shining.

Short erect hairs numerous on anterior scape surface, entire dorsum of alitrunk, petiolar dorsum, and entire surfaces of exposed gastric tergites. Pubescence everywhere abundant, almost entirely appressed.

Body and appendages concolorous clear yellow.

Relationships. This species, marked by its combination of large size, lack of eyes, abundant erect pilosity, and pale color, does not appear to stand close to any of the other species of the *tenuis* group.

Material examined. HAWAII: Oahu, four syntype workers.

This species is known only from the type material, which was collected at several localities on Oahu and on Maui. As in *P. swezeyi*, the collections were all made from the soil of cultivated and fallow sugar-cane fields, a circumstance which suggests that the species may have been introduced into Hawaii by man.

Characterization of the *Ponera selenophora* group

Worker. Medium-sized species, worker head width ranging between 0.43 and 0.68 mm. Mandibular dentition variable, in most cases consisting of three distinct teeth occupying the apical two-fifths to one-half of the masticatory border, followed by a series of minute denticles; in one case (*selenophora*) the basal half of the border bears two distinct teeth in addition to the denticles. Eyes usually small, with 3-5 indistinct facets; in one case (*elegantula*) there are 11-12 facets. Junction of posterior and lateral faces of propodeum marginate, forming an angle of 80° to slightly less than 90°. Petiolar node massive and exceptionally broad, its dorsal width never less than 0.77 × the pronotal width and usually much more; arcuate or crescentic, with the junction of the anterior and posterior faces usually marginate. Subpetiolar process very variable in shape, from well developed and angular or subangular to rudimentary and rounded; when well developed, its apex generally projects posteriorly.

Key to the species of the *Ponera selenophora* group, based on the worker

1. Small species, head width 0.43-0.47 mm; dorsum of alitrunk completely devoid of standing hairs; (New Guinea to New Hebrides) .... *clavicornis* Emery

   Larger species, head width 0.50 mm or greater; dorsum of alitrunk either covered by abundant standing hairs (usually) or else completely devoid of standing hairs (the latter condition only in one species from New Guinea) 2

2. Entire lateral surface of the propodeum completely sculptured and opaque; (a larger species, head width 0.62-0.64 mm, with unusually long scapes, scape index 90-93); (Japan) ..... *scabra* Wheeler

   A large part of the lateral faces of the propodeum smooth and shining; (species variable in size, with shorter scapes, scape index 89 or less) 3

3. (Based on unique type). Head more elongate (cephalic index 80), with relatively large eyes containing 11 or 12 distinct facets; alitrunk completely devoid of standing hairs; (mountains of northeastern New Guinea) ..... *elegantula* Wilson, n. sp.
   Head proportionately shorter (cephalic index 86 or greater), with smaller eyes containing only 3-5 indistinct facets; alitrunk covered with abundant standing hairs 4
4. Smaller species (head width 0.50 mm) with proportionately short head (cephalic index 92-94); antennal club indistinctly 4-jointed; (Philippines) ..... *oreas* (Wheeler)
   Either slightly larger species (head width 0.52-0.54 mm) with much longer head (cephalic index 85-87), or much larger species (head width 0.59 mm or greater) with head equally long to much longer (cephalic index 86-92); antennal club either 5-jointed or completely undifferentiated 5
5. Posterior face of petiolar node feebly but distinctly convex; a relatively small species (head width of unique type 0.52 mm) from the mountains of northeastern New Guinea ..... *syscena* Wilson, n. sp.
   Posterior face of petiolar node flat or feebly concave 6
6. Smaller species (head width of unique type 0.54 mm); anterior surface of scape with abundant erect hairs; antennal club indistinctly 5-jointed; (Hongkong) ..... *sinensis* Wheeler
   Larger species (head width 0.59 mm or greater); erect hairs scarce to absent on anterior surface of scape; antennal club undifferentiated 7
7. Smaller species (head width 0.59-0.63 mm); basal half of masticatory border bearing two distinct teeth which are nearly as large as the three teeth of the apical half; posterior border of petiolar node, seen from directly above, distinctly concave; (lowland rainforests of Papua and northeastern New Guinea) ..... *selenophora* Emery
   Larger species (head width 0.65-0.68 mm); basal half of masticatory border bearing only minute denticles which do not approach in size the three apical teeth; posterior border of petiolar node, seen from directly above, straight; (mountains of northeastern New Guinea) ..... *xenagos* Wilson, n. sp.

Ponera clavicornis Emery

Ponera clavicornis Emery, 1900, Természetr. Füz., 23: 317, pl. 8, figs. 7, 8, worker. Type locality: Friedrich-Wilhelmshafen (=Madang), N-E. New Guinea.

Ponera clavicornis, Mann, 1919, Bull. Mus. Comp. Zool., 63: 296.

Selenopone clavicornis, Wheeler, 1933, Amer. Mus. Nov., no. 672: 22.

Worker. HW 0.43-0.47 mm, HL 0.52-0.59 mm, SL 0.35-0.42 mm, CI 81-85, SI 80-89, PW 0.32-0.37 mm, dorsal petiole width 0.27-0.32 mm. Mandibles with three well developed teeth occupying about the apical half of the masticatory border; the basal half occupied by an indeterminate number of minute denticles. Eye as described for *P. selenophora.* Antennal club relatively slender, 5-jointed. Posterolateral margins of propodeum relatively poorly defined, seen from directly above forming an angle of only slightly less than 90°. Posterior face of petiolar node seen from directly above almost perfectly straight. Subpetiolar process variable in shape, ranging from a rudimentary convexity to a strong right-angular projection.

Mandibles smooth and shining; clypeus feebly shagreened and shining over most of its surface; entire remainder of the head densely, finely, and evenly punctate (the punctures mostly under 0.01 mm in diameter) and completely opaque. Entire dorsal and lateral alitrunkal surfaces similarly punctate and opaque, except for the ventral margins of the sides of the pronotum, a limited central longitudinal strip on the sides of the propodeum, and the lower half of the posterior propodeal face, which surfaces are more or less smooth and shining. Dorsal and lateral surfaces of petiolar node somewhat less densely punctate than head and alitrunk, subopaque; anterior and posterior faces more or less smooth and shining. First several gastric tergites also somewhat less densely punctate, subopaque to feebly shining.

Pilosity completely lacking on head and alitrunk except for a few erect hairs on the mandibles, clypeus, and frontal lobe area. Petiolar node and first two gastric tergites bare to sparsely pilose; terminal gastric tergites and all gastric sternites abundantly pilose.

Body (except mandibles and apical gastric segments) piceous brown, approaching jet black. Mandibles, apical gastric segments, and appendages yellowish brown.

Geographic variation. The series from Espiritu Santo, New Hebrides, have somewhat longer scapes than those from New Guinea (SI 86-89 as opposed to 80-84).

The series from Bisianumu, Papua, have the first two gastric tergites pilose; in side view 5-10 standing hairs are visible along the profile of the first tergite. The series from Tumnang, N-E. New Guinea, and from the New Hebrides have the first two

gastric tergites bare of pilosity. The series from Bubia, N-E. New Guinea, a geographically intermediate locality, has the tergites intermediately pilose: 1-3 standing hairs are visible along the profile of the first tergite.

Relationships. This is a very distinct species, easily separated in the worker caste from other members of the *selenophora* group by the combination of smaller size, distinctive sculpturing, and sparse body pilosity.

Material examined. PAPUA: Bisianumu, 500 m., March 15-20, 1955 (Wilson, acc. nos. 608, 626, and 648, the last with winged queens). N-E. NEW GUINEA: Madang, syntype worker (Emery Coll.); Bubia, 13 km. northwest of Lae, March 26, 1955 (Wilson acc. no. 680); lower Busu River, May 1955 (Wilson acc. no. 1006); Tumnang, Mongi River Watershed, 1500 m., April 14-15, 1955 (Wilson acc. no. 798). SOLOMONS: Santa Isabel (Mann, 1919). NEW HEBRIDES: A. Ratard Plantation, 8 km. southwest of Luganville, Espiritu Santo, January 7-13, 1955 (Wilson acc. no. 348); Malua Bay, Malekula (L. E. Cheesman). My accessions no. 608 and no. 798 were compared directly with a worker syntype in the Emery Collection.

Ecological notes. This is an exceptionally adaptable and widespread species. It has been collected from primary lowland rainforest (Espiritu Santo), second-growth lowland rainforest (Bubia), foothills forest (Bisianumu), and true midmountain forest (Tumnang), under a variety of local ecological conditions.

My accession no. 608 (Bisianumu) was a small colony found nesting under the bark of a large "passalid-stage" log on the ground; larvae at various stages of development and cocoons were present. The other two Bisianumu accessions and the Bubia accession consisted of stray workers, also from large passalid-stage logs. The Tumnang and New Hebrides specimens were taken as strays in leaf litter on the forest floor.

Ponera elegantula Wilson, n. sp.

Holotype worker. HW 0.56 mm, HL 0.70 mm, SL 0.49 mm, CI 80, SI 87, PW 0.43 mm, petiolar node length 0.38 mm, dorsal petiole width 0.38 mm. Apical half of masticatory border of (left) mandible occupied by three well-developed teeth; posterior half occupied by six irregular denticles. Eyes relatively large,

maximum length 0.06 mm, with eleven or twelve distinct facets. No distinct antennal club differentiated; funicular segments from the third outward gradually increasing in length and width. Head subrectangular, its sides feebly convex, its posterior border feebly concave. Posterolateral margins of propodeum distinct but rounded, seen from above forming only slightly less than a 90° angle. Petiolar node in side view considerably thinner than in any other *selenophora* group member, although exhibiting the form and exceptional transverse width typical for the group. Seen from directly above, the dorsal surface of the node is thin and arc-shaped.

Mandibles smooth and feebly shining; clypeus for the most part smooth and feebly shining. Remainder of head covered by punctures which are about 0.006 mm in diameter and separated from one another by about the same distance; its surface feebly shining. Dorsal surface of alitrunk covered by similar punctures somewhat more widely spaced, its surface feebly shining; punctures on sides of pronotum sparser, finer, the surface moderately shining; lower halves of episterna finely and very sparsely punctate, their surfaces strongly shining, upper halves finely shagreened and subopaque; lower halves of metapleura and of the sides of the propodeum shagreened and subopaque, upper halves finely and sparsely punctate and shining; posterior face of propodeum smooth and shining. Petiolar surfaces very sparsely punctate to smooth, moderately to strongly shining. Gastric tergites sculptured similarly to alitruncal dorsum.

Body pilosity very sparse, limited to anterior region of head, posterior strips of first two gastric tergites, entire surfaces of apical gastric tergites, and entire surfaces of all gastric sternites. Pubescence everywhere abundant and appressed.

Body color, excluding mandibles and apical gastric tergites, jet black. Mandibles, apical gastric tergites, and appendages yellowish brown.

Paratype queen. HW 0.62 mm, HL 0.76 mm, SL 0.53 mm, CI 82, SI 86. Distinguished from the worker by the usual queen-worker caste differences. Maximum eye length 0.16 mm. Unlike the queens of other members of the *tenuis* and *selenophora* groups, the queen of *elegantula* does not have a proportionately more slender petiolar node than the worker.

Relationships. This species, with its distinctively large eye

size and relatively slender petiolar node, does not appear to be closely related to any of the other members of the *selenophora* group.

Material examined. N-E. NEW GUINEA: Tumnang, Mongi River Watershed, Huon Peninsula, 1500 m.; April 14-15, 1955; one worker and one dealate queen (Wilson, acc. no. 799).

Ecological note. The two type specimens were taken together under the bark of a rotting log in midmountain rainforest.

Ponera oreas (Wheeler)

Selenopone oreas Wheeler, 1933, Amer. Mus. Nov., no. 672: 20-21, fig. 8, worker. Type locality: Cuernos Mts., 1300 m., near Dumaguete, Negros Oriental, Philippines.

Worker. HW 0.50 mm, HL 0.54 mm, SL 0.39 mm, CI 93, SI 78, PW 0.36-0.38 mm, dorsal petiole width 0.29-0.31 mm. Closely related to the members of the *selenophora* "subgroup" (see under *selenophora*) and distinguished principally by the following characters:

(1) Somewhat smaller size.

(2) The antennal club is four-jointed; the fifth funicular segment from the apex is slightly larger than the succeeding basal segments, but still not large enough to be considered part of the club, as is the case in *P. sinensis*.

(3) The head is proportionately shorter than in any other member of the *selenophora* group.

Relationships. See comparative description above.

Material examined. PHILIPPINES: Cuernos Mts., four syntype workers.

Ponera scabra Wheeler

Ponera scabra Wheeler, 1928, Boll. Lab. Zool. Portici, 21: 99-100, worker, queen. Type locality: Mt. Maya, Japan (present selection).

Worker. HW 0.62-0.64 mm, HL 0.77-0.80 mm, SL 0.56-0.59 mm, CI 78-82, SI 90-93, PW 0.46-0.50 mm, dorsal petiole width 0.39-0.42 mm. This species falls close to the *selenophora* "subgroup" (see under *selenophora*), and can easily be distinguished from it by the following two characters:

(1) The head is proportionately longer (maximum CI is 82 as opposed to a minimum of 85 in the *selenophora* subgroup).

(2) The entire alitrunk, except the posterior surface of the propodeum, is coarsely and irregularly shagreened and subopaque to opaque.

Relationships. See comparative description above.

Material examined. JAPAN: Mt. Maya, Honshu, six syntype workers.

Ponera selenophora Emery

Ponera selenophora Emery, 1900, Természetr. Füz., 23: 317, pl. 8, figs. 4, 6, worker. Type locality: Lemien, near Berlinhafen (Aitape), N-E. New Guinea.

Selenoponc selenophora, Wheeler, 1933, Amer. Mus. Nov., no. 672: 21.

Worker. HW 0.59-0.63 mm, HL 0.66-0.69 mm, SL 0.52 mm, CI 88-92, SI 82-89, PW 0.46-0.49 mm, dorsal petiolar width 0.40-0.42 mm. Mandibles with three relatively large, well-developed teeth occupying the apical half of the masticatory border; the basal half occupied by two smaller teeth, one located midway between the basalmost of the apical teeth and the basal angle, and the other on the basal angle. In addition, there are several irregular denticles in the interdentary spaces of the basal half of the border. Eyes minute, consisting of two or three small, ill-defined ommatidia, located approximately 0.8 the distance from the lateral occipital border to the midpoint of the anterior genal border. The antenna lacks a well-defined club, the funicular segments merely increasing gradually in length and width from the fourth outward. Posterolateral margins of propodeum (line of juncture of posterior and lateral faces) well marked, seen from directly above forming an angle of about 80°. Posterior border of petiole when viewed from directly above distinctly concave. Subpetiolar process well developed, approximately right-angular.

Mandibles and most of clypeus smooth and shining. Entire rest of head covered by contiguous punctures about 0.01 mm or slightly less in diameter, completely opaque. Entire dorsum of alitrunk covered by punctures about 0.006 mm in diameter, separated by spaces of about the same width as the diameter of the punctures, the surface feebly shining. Lateral thoracic surface covered by punctures of variable size, most with diameter under 0.01 mm, the majority contiguous; the surface subopaque.

The lateral and posterior propodeal faces bear only a few peripherally distributed punctures and are mostly smooth and shining. Petiolar node with sparse scattered punctures, its surface entirely smooth and shining.

Short, erect hairs present on mandibles, clypeus, frontal lobe area, entire dorsal alitruneal surface, posterolateral propodeal margins, dorsal petiolar surface, and entire surfaces of first two gastric segments. Apical gastric segments covered by more abundant, much longer hairs. Pubescence almost everywhere abundant, predominantly oblique to appressed.

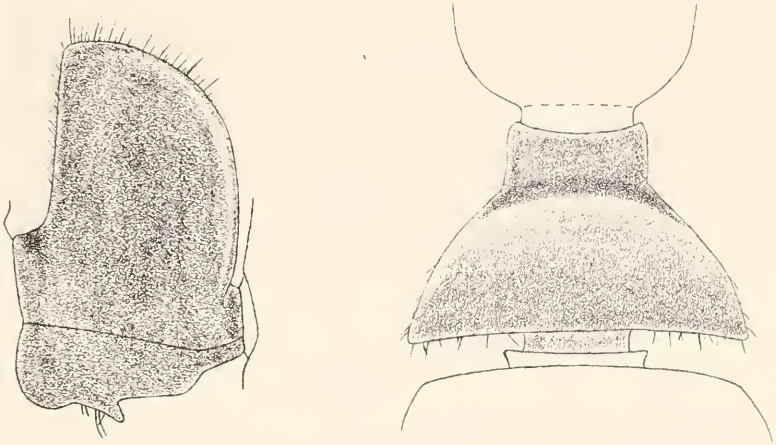

Fig. 3. Lateral and dorsal views of the worker petiole of *Ponera selenophora* Emery. Based on a worker from Karema, Papua, which had been compared with a syntype in the Emery Collection.

Entire body jet black, except mandibles and apical gastric segments, which are brownish yellow. Appendages variably brownish yellow.

Relationships. Inside the *selenophora* group, *P. selenophora* falls within the closely knit subgroup which also includes *P. xenagos* Wilson, *P. syscena* Wilson and *P. sinensis* Wheeler. Distinguishing characters are supplied in the respective comparative descriptions of these latter species.

Material examined. N-E. NEW GUINEA: Lemien, near Berlinhafen (=Aitape), syntype worker; lower Busu River, near

Lae, April 28, 1955 (E. O. Wilson, acc. no. 564). PAPUA: Karema, near Brown River, March 8-11, 1955 (Wilson, acc. no. 564). NETH. NEW GUINEA: Maffin Bay, June, 1944, a single dealate queen (E. S. Ross). The Karema specimens have been compared directly with a worker type in the Emery Collection.

Ecological note. Both of the author's collections were made on the floor of primary lowland rainforest.

Ponera sinensis Wheeler

Ponera sinensis Wheeler, 1928, Boll. Lab. Zool. Portici, 22: 6-7, worker. Type locality: Hongkong.

Holotype worker. HW 0.54 mm, HL 0.62 mm, SL 0.45 mm, CI 87, SI 83, PW 0.41 mm, dorsal petiole width 0.35 mm. Very close to *P. selenophora* and *P. syscena,* differing primarily by the following combination of characters:

(1) Intermediate size.

(2) Apical five segments of antenna differentiated as a club.

(3) Posterior face of petiolar node feebly but distinctly concave, approximately intermediate between *selenophora* and *xenagos.*

(4) Pilosity and pubescence approximately as described for *syscena.*

(5) Propodeal margination as described for *xenagos.*

(6) Basal half of masticatory border of mandible bearing only denticles.

Relationships. See comparative description above.

Material examined. Hongkong, holotype worker.

Ponera syscena Wilson, n. sp.

Holotype worker. HW 0.52 mm, HL 0.61 mm, SL 0.45 mm, CI 85, SI 87, PW 0.40 mm, petiolar height 0.39 mm, petiolar node length 0.26 mm, dorsal petiole width 0.31 mm. Closely related to *P. selenophora* Emery and *P. sinensis* Wheeler, differing primarily by the following combination of characters:

(1) Small size, distinctly smaller than the probably sympatric *P. selenophora* but scarcely smaller than *P. sinensis.*

(2) Dorsal petiole width only 0.78X the pronotal width, as opposed to at least 0.82X in *selenophora* and *sinensis.* Posterior

face of petiolar node feebly convex (feebly concave in *selenophora* and *sinensis*).

(3) Propodeal margination as described for *P. xenagos*.

(4) Body and appendages with considerably more abundant pilosity and pubescence than in *selenophora*. Thirteen to seventeen outstanding erect hairs can be counted along the outer surfaces of the scapes in the *syscena* type, whereas there are no more than five or six in *selenophora*. *P. sinensis* is close to *P. syscena* in this character.

(5) Dentition of basal half of masticatory border of mandible bearing only denticles.

Relationships. See comparative description above. Although this species closely resembles *P. selenophora* in most characters, it has a petiolar node form (*q. v.*) which is intermediate between the distinctive *selenophora* type and the more generalized type characterizing most of the species of *Ponera*.

Material examined. N-E. NEW GUINEA: native trail between Yunzain and Joangeng, Mongi Watershed, Huon Peninsula, 1300 m.; April 7, 1955; a single worker (Wilson).

Ecological note. The unique type was taken as a stray on the floor of midmountain rainforest.

Ponera xenagos Wilson, n. sp.

Holotype worker. HW 0.67 mm, HL 0.77 mm, SL 0.59 mm, CI 87, SI 88, PW 0.52 mm, petiole height 0.53 mm, petiolar node length 0.27 mm, dorsal petiole width 0.42 mm. Very similar to *P. selenophora* Emery, differing by the following characters:

(1) Larger size.

(2) The three apical mandibular teeth occupy less than half the masticatory border, and distinct teeth are not developed on the basal half of the border as described for *selenophora*.

(3) The posterolateral margins of the propodeum are less pronounced; viewed from directly above they form an angle of only a little less than 90°.

(4) When viewed from directly above, the posterior margin of the petiolar node is almost perfectly straight, as opposed to the distinctly concave margin of *selenophora*.

(5) Pubescence is generally sparser. The anterior face of the petiolar node has pubescence only over its upper quarter,

and there it is relatively sparse, whereas in *selenophora* it is abundant over the entire upper half.

Paratype variation. HW 0.65-0.68 mm, HL 0.75-0.80 mm, SL 0.57-0.60 mm, CI 86-90, SI 83-89, PW 0.52-0.54 mm, dorsal petiole width 0.40-0.44 mm.

Relationships. P. xenagos is the largest of the known species of the *selenophora* group. Within the group, it is most closely allied to *selenophora* itself, as indicated in the above comparative description.

Material examined. N-E. NEW GUINEA: Tumnang, 1500 m. (type locality), April 14-15, 1955, holotype and eight paratype workers (Wilson, acc. no. 801); Ebabaang, 1300-1400 m., April 16-18, 1955, three paratype workers (Wilson, acc. no. 819). Both of the above localities are in the Mongi River Watershed of the Huon Peninsula.

Ecological notes. The Tumnang colony was found nesting under the loose bark of a rotting stump. The Ebabaang colony was under the loose bark of the upper surface of a large rotting log, in the immediate vicinity of a colony of *Amblyopone australis* Erichson. Both nest sites were in partial clearings at the side of native trails running through dense midmountain rainforest.

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AT HARVARD COLLEGE
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THE CHINESE CAENERESSA SPECIES (LEPIDOPTERA, CTENUCHIDAE)

By Nicholas S. Obraztsov

With Four Plates

CAMBRIDGE, MASS., U. S. A.
PRINTED FOR THE MUSEUM
June, 1957

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No. 7 — *The Chinese Caeneressa Species (Lepidoptera, Ctenuchidae)*

By Nicholas S. Obraztsov

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INTRODUCTION

Some years ago, while the author was doing research on Ctenuchidae and other Lepidoptera families at the Zoological Collection of the Bavarian State in Munich, he had an opportunity to study

not only the materials of that museum but also a very extensive collection from China gathered in the course of many years by the indefatigable investigator of the Lepidoptera of this country, Dr. H. Höne. This collection, now one of the most important components of the Institute of Zoological Research and Museum Alexander Koenig in Bonn, gave the author a basis for revision of several Chinese Ctenuchidae species in which he was especially interested. Further materials for this revision were found in collections of the Museum of Comparative Zoology in Cambridge, the American Museum of Natural History in New York, and the U. S. National Museum in Washington. The species of the related Oriental fauna were studied from the collections of the three last-mentioned museums and the State Museum of Natural History in Leiden. The necessary knowledge about the type specimens of Ctenuchidae from China, previously described by earlier authors, was received by the author from the British Museum (Natural History).

The new genus treated in this paper represents a small group of species ranging through China and the Oriental Region. These species have up to the present time been considered as belonging to the genus *Amata* F. from which they differ both in the structure of hind tibiae and in the male genitalia. The female genitalia could not be closely studied because the preparation of these parts involved the complete destruction of the markings of the abdomen which are very important for taxonomy of the *Caeneressa* species.

The present paper may be considered as a complete revision of the Chinese *Caeneressa* species, so far as they are known. Concerning some species ranging also beyond China, it was possible to add information about their distribution and geographical variation in other countries.

The author wishes to express his gratitude for the friendly cooperation of the Direction of the Zoological Collection of the Bavarian State in Munich (Germany) in the person of Prof. H. Krieg and the Curator of its Department of Entomology, Dr. W. Forster, and thus for the author's opportunity to devote most of his working-hours to research work. Hearty thanks also go to Dr. H. Höne of the Institute for Zoological Research and Museum Alexander Koenig in Bonn (Germany) for putting his rich collection at the author's disposal; Dr. P. J. Darlington, Jr.,

of the Museum of Comparative Zoology in Cambridge, Mass., and Dr. F. H. Rindge of the American Museum of Natural History in New York for the opportunity to study materials in these museums; Mr. J. F. Gates Clarke and Mr. W. D. Field of the U. S. National Museum in Washington, D. C., for a similar opportunity with respect to the materials of that museum; Dr. A. N. Diakonoff of the State Museum of Natural History in Leiden (The Netherlands) for sending moths for study; Mr. W. H. T. Tams of the British Museum (Natural History) in London for sending photographs of the type specimens of *Caeneressa* species in this museum and their genitalia, and for a great deal of work connected with this important aid; Mr. S. G. Kiriakoff of the Zoological Laboratories of the University of Ghent (Belgium) for some information about the above types; Mr. F. Daniel of the Zoological Collection of the Bavarian State for his continual assistance in the interpretation of labels in Dr. Höne's collection; Mrs. F. Tandler in Arlington, Va., for her kind assistance in the preparation of the English text of the present paper. The author acknowledges with thanks the support of his work on this paper by a research grant (1952) of the Research Program on the U.S.S.R. (East European Fund, Inc.) in New York; this grant gave him the opportunity to study the materials and the literature in the museums of the United States.

ABBREVIATIONS

The following abbreviations of the names of collections are used in the paper:

A.M.N.H., American Museum of Natural History, New York.

B.M., British Museum (Natural History), London.

M.C.Z., Museum of Comparative Zoology at Harvard College, Cambridge, Mass.

M.K., Institute for Zoological Research and Museum Alexander Koenig (''Zoologisches Forschungsinstitut und Museum Alexander Koenig, Reichsinstitut''), Bonn, Germany.

M.L., State Museum of Natural History (''Rijksmuseum van Natuurlijke Historie''), Leiden, The Netherlands.

U.S.N.M., U.S. National Museum, Washington.

Z.C.M., Zoological Collection of the Bavarian State (''Zoologische Sammlung des Bayerischen Staates''), Munich, Germany.

SYSTEMATIC DESCRIPTIONS

Caeneressa, new genus

Syntomis (part.) Kollar, 1848, Hügel's Kaschmir, **4** (2), p. 460; Walker, 1854, List Spec. Lep. Ins. B. M., **1**, p. 117; Herrich-Schäffer, 1858, Samml. neuer oder wenig bekannt. aussereurop. Schmett., p. 72; Felder, 1862, Wien. Ent. Mschr., **6**, p. 37; Moore, 1871, Proc. Zool. Soc. London, p. 244; Butler, 1876, J. Linn. Soc. London, Zool., **12**, p. 344; 1877, Illustr. Het. B. M., **1**, p. 17; Moore, 1878, Proc. Zool. Soc. London, p. 845; 1878, Anderson's Res. W. Yunnan, p. 296; Poujade, 1886, Bull. Soc. Ent. France (6), **6**, p. CXVII; Swinhoe (and Cotes), 1887, Cat. Moths Ind., p. 45; Leech, 1889, Trans. Ent. Soc. London, p. 123; Hampson, 1892, Fauna Brit. India, Moths, **1**, p. 212; Swinhoe, 1895, Trans. Ent. Soc. London, p. 30; Hampson, 1897, J. Bombay N. H. Soc., **11**, p. 284; Leech, 1898, The Entom., **31**, p. 152; 1898, Trans. Ent. Soc. London, p. 319; Hampson, 1898, Cat. Lep. Phal., **1**, p. 59; 1900, J. Bombay N. H. Soc., **13**, p. 46; Piepers en Snellen, 1904, Tijdschr. v. Ent., **47**, p. 51; Seitz, 1909, Gross-Schm. Erde, **2**, p. 38; Matsumura, 1911, Thousand Ins. Jap., Suppl., **3**, p. 69; Zerny, 1912, Wagner's Lep. Cat., **7**, p. 12; Seitz, 1912, Gross-Schm. Erde, **10**, p. 67; Van Eecke, 1925, Zool. Meded. Rijksmus. Leiden, **8**, p. 208; Draeseke, 1926, Iris, **40**, p. 46; Wileman, 1929, Trans. Ent. Soc. London, **76**, p. 420; Matsumura, 1931, 6000 Illustr. Ins. Jap., p. 995; Kawada, 1934, Cat. Ins. Jap., **5**, Lep. Syntomidae, p. 1; Wu, 1938, Cat. Ins. Sin., **4**, p. 629; Sonan, 1941, Trans. N. H. Soc. Formosa, **31**, p. 95.

Hydrusa (part.) Swinhoe, 1891, Trans. Ent. Soc. London, p. 473; 1892, Cat. East. and Austral. Lep. Het., **1**, p. 50; Kirby, 1892, Synon. Cat. Lep. Het., **1**, p. 902; Hampson, 1892, Fauna Brit. India, Moths, **1**, p. 220; 1898, Cat. Lep. Phal., **1**, p. 66; Kiriakoff, 1954, Ann. Mus. Congo Tervuren, in 4°, Zool., **1**, p. 431.

Zygaena (part.) Kirby, 1892, Synon. Cat. Lep. Het., **1**, p. 89.

Eressa (part.) Hampson, 1892, Fauna Brit. India, Moths, **1**, p. 221; Swinhoe, 1895, Trans. Ent. Soc. London, p. 32.

Amata (part.) Rothschild, 1910, Novit. Zool., **17**, p. 433; 1912, *ibid.*, **19**, p. 375; Hampson, 1915, Cat. Lep. Phal., Suppl., **1**, (1914), p. 13; Fletcher, 1925, Cat. Ind. Ins., **8**, p. 6; Matsumura, 1927, J. Coll. Agr. Hokkaido Univ., **19**, p. 74; Candèze, 1927, Enc. Ent. (B), Lepidoptera, **2**, p. 74; Joannis, 1928, Ann. Soc. Ent. France, **97**, p. 245.

Head rather roughly scaled, the frons usually a little more smooth. Antennae bipectinate or serrate in the male, serrate or simple in the female, sometimes simple in both sexes, always ciliate. Palpi labiales porrect, rather short, roughly scaled,

with a subacute terminal joint. Proboscis moderately long, weak. Legs smooth, only the coxae somewhat rougher scaled from the exterior side; hind tibiae without middle spurs, with a pair of terminal ones only. Abdomen smoothly scaled.

Forewing moderately broad, dilated outward; dorsum nearly two thirds as long as the costa; termen straight or slightly convex; 12 veins; R_1 to R_5 stalked; M_1 from upper angle of the middle cell; M_2 and M_3 shortly stalked, connate or slightly separate, from the lower angle of the middle cell; Cu_1 from well before the angle of the middle cell; Cu_2 from more or less behind the middle point of the middle cell; A_2 more or less arched, extends to the tornus.

Hindwing subovate, shorter than the forewing dorsum; 5 veins; Sc coincident with R and M_1, to the costa; M_2 and Cu_1 connate or shortly stalked, from the lower angle of the middle cell; Cu_2 from cell near three fourths, remote from Cu_1; A_2 to the tornus.

Pattern of the Body and Wings. In their pattern the *Caeneressa* species are similar to most other Ctenuchidae genera of the Eastern Hemisphere. The predominant scaling of the head and body is black or dark brown, often with a blue, greenish or violet, silk or metallic reflection. The markings are formed by white, yellow, orange, or red scaling on the dark ground; sometimes the dark scaling is completely replaced by these colored scales or pushed into the background. On the head the colorous markings may be represented as a patch on the frons, also as streaks on the cheeks; exceptionally the dark ground of the head is completely taken over by the colorous scaling. On the patagia the dark ground is often similarly replaced, or they are patched with color. The tegulae are usually more or less widely patched with color, sometimes without any black. On the thorax colorous markings (streaks and patches) are often present; the pectus usually with lateral patches. The interior side of the coxae and some other parts of the legs are often colored, especially in the males. The pattern of the abdomen is formed of variously developed transverse segmental bands and girdles, complete or interrupted on the dorsal or ventral surface; longitudinal lines are also sometimes present. The scaling of the body and its parts is never more than trichromatic, usually it is bichromatic.

The wing pattern of *Caeneressa* is similar to that of *Amata* F. and formed by hyaline spots on a dark ground. In this way, the wing pattern scheme of this latter genus (cf. Obraztsov, 1935, Ent. Anz., **15**, p. 262; 1941, Univ. Kijev., Acta Mus. Zool., **1**, (1939), p. 114) can be used also in *Caeneressa*. In the forewing a triangular spot (m_2) is in the middle cell. A more or less long spot ($m_1 + m_3$ of the *Amata* wing pattern scheme) is below the middle cell, in the interspace between it and the vein A_2; an ovate or more or less elongate spot (m_4) is in the basal part of the interspace between the veins R_5 and M_1; two spots (m_5 and m_6) are in the basal parts of the interspaces between the veins M_2 and Cu_1. These last two spots are separated from one another by the vein M_3. Some smaller extra spots are often present; they occur near the basal parts of the interspaces over the vein R_5 and below the vein M_1, also at the outer angle formed by the vein Cu_2 and the middle cell. The subcostal area is sometimes hyaline, the supradorsal area pale scaled.

In the hindwing a basal spot is present. It occupies the interspace between the middle cell, vein Cu_2 and A_2. This spot usually crosses over the vein A_2 and reaches almost to the wing dorsum. Not infrequently it also crosses over the lower vein of the middle cell which latter is in this case at least partly hyaline. The second hindwing spot is a distal one. It occupies the basal part of the interspace between the veins Cu_1 and Cu_2 and the middle cell. This spot usually crosses over the vein Cu_1 and reaches to the vein M_2. In case both spots of the hindwing are enlarged and confluent, they occupy most of the surface of the wing, and the hindwing becomes hyaline with dark borders.

Frequently all wing spots are very enlarged, and the wings become predominantly hyaline. In this instance, the dark ground of the forewing is reduced to a discal patch and borders along the wing margins. These borders are usually dilated at the wing apex, often also between the veins Cu_1 and Cu_2. A dark ray along the vein M_2 usually connects the forewing borders with the discal patch. In the hindwing these borders are mostly dentate at the veins Cu_1 and Cu_2. The veins of both wings are always more or less dark.

The wing pattern is bifacial and the under surface matches the upper one. Exceptionally the dark interspaces of the under wing surface are lightened by yellow, whitish or other scales.

Male Genitalia (Fig. 1). Uncus long, more or less curved; tegumen simple or with lateral appendages; saccus variously

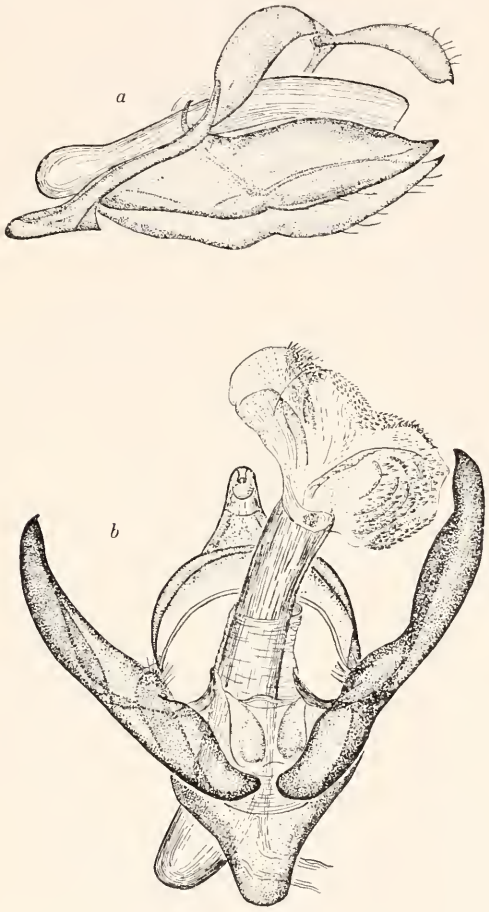

Fig. 1. Male genitalia of *Caeneressa diaphana* (Koll.); preparation no. 2 (M.C.Z.).
a, lateral view; *b*, ventral view.

long, at least moderate. Valvae elongate, variously shaped, sometimes slightly asymmetrical, in this instance the left valva is shorter; the upper edge of the valva (costa) mostly indifferentiate; sacculus more or less thickened, distally rounded, without a free apical point; interior side of the valvae connected with the vallum penis by more or less long processus basales. Vallum penis membranous, only the fultura inferior sclerotized, variously shaped. Aedoeagus moderate or long, more or less straight or slightly curved; coecum penis moderate or underdeveloped; vesica with a cuneus of numerous, little, chitinous spines, or with well developed elongate cornuti, sometimes with both.

Female Genitalia (Fig. 2). The seventh abdominal segment with a broad, strongly sclerotized tergite and a narrow, less sclerotized sternite; it forms caudad a wide, roundish opening into which the papillae anales are retracted in the position of rest. The postsegmental edge of the seventh sternite with a wide indentation displaced to the left which borders with the ostium bursae. The bottom of the sinus vaginalis membranous, with a narrow, arched sclerite cephalad from the ostium bursae, between it and the postsegmental edge of the seventh sternite. The eighth segment in form of a narrow ring, with a tergite more sclerotized; the eighth sternite semimembranous and forms a kind of medial ventral plate slightly widened at the middle. The narrow, lateral commissurae of both eighth tergite and sternite joined into rather short apophyses anteriores. The papillae anales soft, hairy, broad coniform, the apophyses posteriores nearly three times as long as the apophyses anteriores. Two short, narrow papillae genitales between the papillae anales.

Corpus bursae round, membranous, with a large, dented, sclerotized signum dilated cephalad and constricted and pointed caudad. Cervix bursae wide, with a broad lateral appendix joined to the ductus seminalis. Ductus bursae rather narrower than the cervix, constricted and being stronger near the wide ostium bursae.

The above description of the female genitalia was made from *Caeneressa diaphana* (Koll.) only, and it is not safe to say that it may relate to all species of the genus.

Systematic Position. The new genus *Caeneressa* is closely related to *Eressa* Wkr., *Trichaeta* Swinh. and *Amata* F., and in

the system has to be ranked among this generic group of the Ctenuchidae. From *Eressa* it differs chiefly in the veins M_2 and Cu_1 connate or stalked on the hindwing; the male genitalia

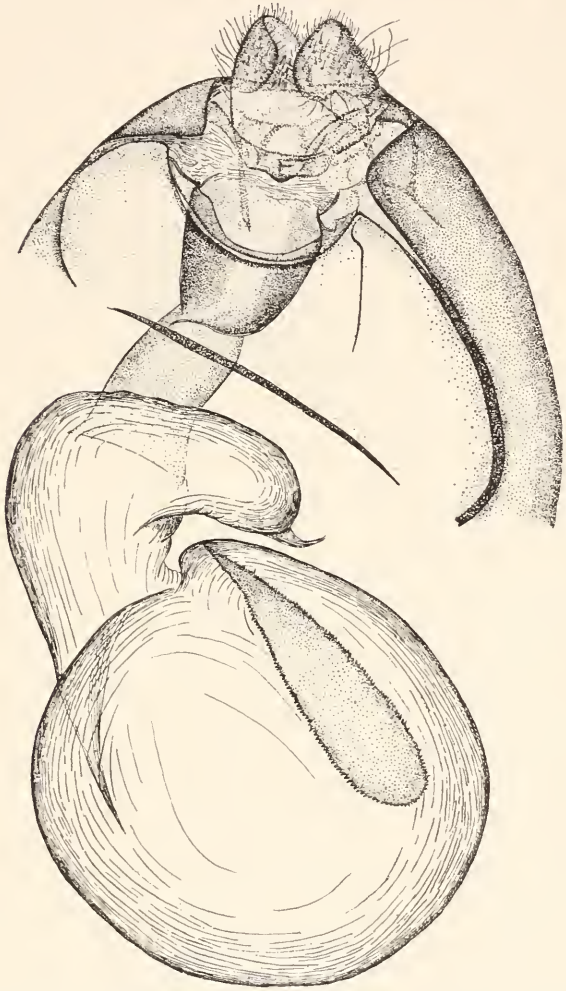

Fig. 2. Female genitalia of *Caeneressa diaphana* (Koll.); preparation no. Ct. 9 (M.L.).

of *Caeneressa* are similar to those of the *multigutta* group of *Eressa*. The new genus resembles especially *Trichaeta*, but differs from it in the absence of the lateral hair-tufts on the abdomen, and in genitalia. The features distinguishing *Caeneressa* from *Amata* consist of the absence of the middle spurs of the hind tibiae and of the male genitalia. The latter in *Caeneressa* do not have any developed upper angle of the valva, and the cornuti are never numerous and ranged in a longitudinal row, both of which features are so typical for *Amata*.

Range. Information about the geographical distribution of the genus *Caeneressa* is currently very insufficient, in so far as the systematic position of many non-Palearctic species ranked under *Amata* F. is not proved. About the non-Palearctic species of the new genus it is only known at present that *albifrons* Moore, *aetea* Swinh., *oenone* Btlr., *era* Swinh. and *serrata* Hmps. belong to *Caeneressa*. In the Palearctic region the genus is represented by thirteen species, seven of them new.

The range of the genus *Caeneressa* is restricted to China (with the north extremity of distribution reaching the southern part of the province of Shensi), North India, Burma, Indo-China, Chusan, Formosa, and the Great Sunda Islands. The most widely distributed species of the genus is *diaphana* Koll. found in almost all parts of this range, while the distribution of other species is very restricted. Except for *diaphana*, all species known to be from China are endemics of this fauna. They have been found in the provinces of Shensi, Szechwan, Kweichow, Yunnan, Anhwei, Hunan, Kiangsu, Chekiang, Kiangsi, Fukien, and Kwangtung. It is very probable that they may be present also in other provinces which have been studied only to a very limited extent. There is evidence that *rubrozonata* Pouj. and *diaphana* Koll. are the most widely distributed *Caeneressa* species in China, although it would be premature to deny wide distribution with respect to the rest of the species of this genus.

Key to the Species,

Based on External Characters

1. Antennae bipectinate in the male, serrate in the female 2
   Antennae serrate in the male, simple in the female, sometimes simple in both sexes 12

2. Abdomen with only transverse, yellow or red bands seldom joined together at the middle line 3
   Abdomen with transverse bands and in addition with longitudinal lateral lines 13
3. No red scaling on any part of the head and body 4
   Head, patagia, tegulae, thorax, and abdomen with red scaling on a black ground ..... *ningyuena*, n. sp.
4. Frons white or greyish 5
   Frons yellow or black 6
5. Patagia black; the elongate spot below the middle cell of the forewing extends farther outward than the spot in the middle cell ..... *proxima*, n. sp.
   Patagia yellow; the elongate spot below the middle cell of the forewing extends no farther outward than the spot in the middle cell ..... *pratti* Leech
6. Patagia black 7
   Patagia yellow, at least laterally 10
7. Hyaline areas between the forewing veins M_2 and Cu_1 extend to the middle cell 8
   Hyaline areas between the above-mentioned veins formed as separate spots which do not reach to the middle cell 9
8. Thorax with a posterior yellow patch; first abdominal tergite with lateral yellow patches ..... *hoenei*, n. sp.
   Thorax without a posterior yellow patch; first abdominal tergite broadly yellow ..... *zernyi*, n. sp.
9. Frons black; tegulae yellow with black end-hair; hindwing with a broad hyaline area ..... *obsoleta* Leech
   Frons diffusely yellow scaled; tegulae yellow only on shoulders; hindwing with two separate hyaline spots ..... *klapperichi*, n. sp.
10. Some of the yellow abdominal bands narrower at the middle ..... *oenone* Btlr.
    The yellow abdominal bands not narrower at the middle 11
11. Head yellow; subcostal area of the forewing hyaline ..... *dispar*, n. sp.
    Head black; subcostal area of the forewing black ..... *swinhoei* Leech
12. Abdomen with transverse bands and also with yellow or red longitudinal lines 13
    Abdomen with yellow transverse bands only ..... *diaphana* Koll.
13. Tegulae yellow or red, at least on shoulders 14
    Tegulae black ..... *graduata* Hmps.
14. Abdomen besides two dorso-lateral yellow lines with a medio-dorsal, longitudinal, yellow line; tegulae entirely yellow ..... *tienmushana*, n. sp.
    Abdomen with two dorso-lateral, longitudinal, yellow or red lines only; tegulae with some black, at least in the end-hairs ..... *rubrozonata* Pouj.

Key to Male Genitalia[1]

1. Proeessus basales of the valvae reach no farther than to the vallum penis 2
   Proeessus basales of the valvae extend far over the vallum penis ..... *zernyi*, n. sp.
2. Uncus dilated distally, shaped like a turkish broadsword 3
   Uncus not dilated distally 7
3. Aedoeagus with a cuneus of numerous, little spines 4
   Aedoeagus with one or two cornuti 5
4. Uncus with a short, pointed tip ..... *diaphana* Koll.
   Uncus with a long, pointed tip ..... *oenone* Btlr.
5. One cornutus 6
   Two cornuti ..... *rubrozonata* Pouj.
6. The left valva shorter; saecus rather long ..... *tienmushana*, n. sp.
   Both valvae almost equally long; saecus short ..... *graduata* Hmps.
7. Saecus broad, rather short 8
   Saecus rather narrow, more or less long 10
8. Cornuti large, strong 9
   Instead of cornuti, two pairs of longitudinal rows of numerous short cones ..... *proxima*, n. sp.
9. Tips of both valvae curved inward; the distal cornutus very broad at the base ..... *pratti* Leech
   Tips of valvae straight; the distal cornutus an almost regular cone ..... *klapperichi*, n. sp.
10. Distal part of the valva with two angles 11
    Distal part of the valva with an acute point 12
11. The left valva distinctly shorter than the right one; its lower angle acute ..... *hoenei*, n. sp.
    Both valvae almost equally long; the lower distal angle of the left valva broad, stout ..... *swinhoei* Leech
12. Tegumen simple; the upper edge of the valva with an acute point; one cornutus ..... *obsoleta* Leech
    Tegumen with lateral appendages; the upper edge of the valva equally arched; three cornuti ..... *dispar*, n. sp.

1. Caeneressa proxima, new species

Pl. 1, figs. 1-3

Male. Antennae bipectinate, black, the apical part of the shaft white. Head black; frons white. Patagia black; tegulae orange-yellow (at least on the shoulders), black bordered. Thorax black

[1] No material available for *ningyuena*, new species, described from a female.

with a narrow, orange-yellow, posterior edge; pectus with two yellow patches on each side. Legs concolorous with the body or slightly paler; the interior side of the fore coxae white; fore tibiae sometimes with white, longitudinal streaks; tarsi more or less long whitish at the base. Abdomen black-brown, shot with greenish or violet; first tergite orange-yellow; second to sixth tergites (incl.) usually with incomplete, orange, postsegmental bands, the fifth segment mostly with such a complete girdle; the corresponding sternites with complete, orange-yellow bands. Wings brownish black, with a dull, violet gloss; spots white-hyaline. Length of the forewing: 25-29 mm.

In the forewing a rather long, wedge-shaped spot (m_2) in the middle cell; a long spot (m_{1+3}) below it which extends much farther outward than the distal edge of the spot in the middle cell; a long spot (m_4) between the veins R_5 and M_1, with two longish extra streaks over these veins; two much broader, egg-shaped spots (m_5 and m_6) between the veins M_2 and Cu_1 separated from each other by the black vein M_3; the upper of these spots slightly shorter than the lower one; a more or less developed, oval extra spot at the base of the vein Cu_2, outward from the long basal spot (m_{1+3}).

The hindwing with a large basal spot which extends from the middle cell to the vein A_2 and is accompanied by a streak behind this vein; a distal spot, almost equal in size to the basal one, more or less separated from it, divided by the black vein Cu_1 into two unequal parts.

Female. Similar to the male. Antennae serrate. Fore coxae entirely black. The orange-yellow band on the sixth abdominal segment mostly absent. The subcostal area of the forewing whitish hyaline, the supradorsal area sometimes whitish.

Male Genitalia (Fig. 3). Tegumen elongate, moderately arched; uncus long, slightly curved downward; saccus broad and large. Valvae almost symmetrical, with a strong, thickened sacculus; distal edge of the valva dentate; the whole valva equally narrowed toward the rounded tip; processus basales curved, extending to the upper part of the vallum penis. Fultura inferior bottle-shaped. Aedoeagus rather thick, moderately curved downward, funnel-shaped at the tip; coecum penis rudimentary, broad; cuneus of numerous short cones forming two pairs of longitudinal rows.

Types. Holotype, male, Lienping, Province Kwangtung, May, 1922, H. Höne (genitalia preparation no. S.050; M.K.); allotype, female, Hoengshan, Province Hunan, May 29, 1933, H. Höne (M.K.); paratypes, two males, Lienping, Province Kwangtung, May, 1922, H. Höne (M.K. and Z.C.M.).

Additional material examined. Two females, Yenping, Province Fukien, June 13, 1917 (A.M.N.H.); one female, Nanking, Province Kiangsu, June 15, 1933, H. Höne (Z.C.M.).

Range. Chinese provinces Kwangtung, Fukien, Hunan, and Kiangsu.

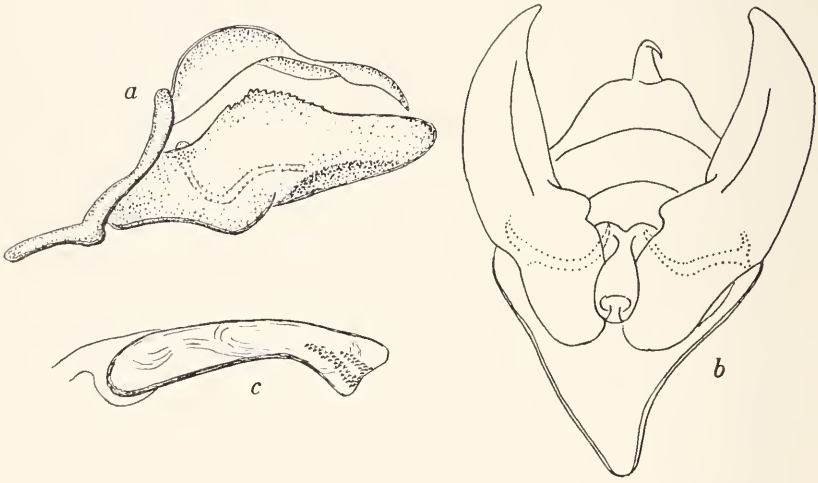

Fig. 3. Male genitalia of *Caeneressa proxima,* new species; preparation no. S.050 (M.K.).
a, lateral view; *b,* ventral view; *c,* aedoeagus.

Remarks. Superficially very similar to *pratti* Leech and *klapperichi,* n. sp., except for a much longer forewing spot (m_{1+3}) below the middle cell. Moreover, *proxima* can be distinguished from *pratti* by the black color of the patagia and dissimilar color of the fore coxae. The markings of the abdomen of *proxima* are unlike those of *klapperichi;* also the frons scaling is white, not yellowish as in this species.

2. Caeneressa klapperichi, new species

Pl. 1, figs. 7, 8

Male. Antennae bipectinate, black, the apical three-fourths of their shafts white. Head black; frons diffusely pale-yellow scaled. Patagia and tegulae black, the latter with yellow shoulders. Thorax violet-brown, with a narrow, yellow, posterior edge; pectus with two yellow patches on each side. Legs concolorous with the body; the interior side of the fore coxae whitish yellow; tarsi whitish scaled. Abdomen violet-brown; first tergite orange-yellow; second to seventh segments (incl.) with complete, orange-yellow, postsegmental girdles. Wings brownish black with a coppery gloss; spots white-hyaline. Length of the forewing: 21 mm.

In the forewing a rather short, wedge-shaped spot (m_2) in the middle cell; an elongate spot (m_{1+3}) below it extends farther outward than to the middle of the above spot; an almost equally broad, elongate spot (m_4) between the veins R_5 and M_1, with two much smaller, elongate extra spots over these veins; two rather short, egg-shaped spots (m_5 and m_6) between the veins M_2 and Cu_1 separated from each other by the black vein M_3; the upper of these spots slightly shorter than the lower one.

The hindwing with a rather large, roundish basal spot which extends from the middle cell almost to the dorsum; a separate distal spot divided by the black vein Cu_1 into two unequal parts; the middle cell whitish scaled.

Female. Similar to the male. Antennae serrate. Yellow of the tegulae only slightly developed. Abdomen with the first tergite orange-yellow; similarly colored, incomplete, postsegmental bands on the fourth and fifth segments. Forewing broader than in the male, all spots larger; the extra spot located between the spots m_4 and m_5 contiguous with both; a little extra spot above the base of the vein Cu_2; the subcostal area hyaline. The middle cell of the hindwing partly hyaline. Length of the forewing: 26 mm.

Male Genitalia (Fig. 4). Tegumen strongly arched; uncus long, dilated at the middle, strongly curved downward; saccus short. Valvae almost symmetrical, with a narrow, slightly thickened sacculus; distal edge of the valva dentate; the whole valva

equally narrowed toward the truncate tip; processus basales angularly curved, hardly reaching with their tips to the vallum penis. Fultura inferior subquadrate. Aedoeagus rather short and thick, with a coecum penis directed downward; a large, thick, claw-shaped cornutus on the tip of the vesica, and a much shorter one at its middle; some fine, sclerotized dotting at the bases of these cornuti and above the second of them.

Types. Holotype, male, Kuatun, Province Fukien, 2300 m.alt., June 16, 1938, J. Klapperich (genitalia preparation no. S.046; M.K.); allotype, female, the same locality, June 20, 1938, J. Klapperich (M.K.).

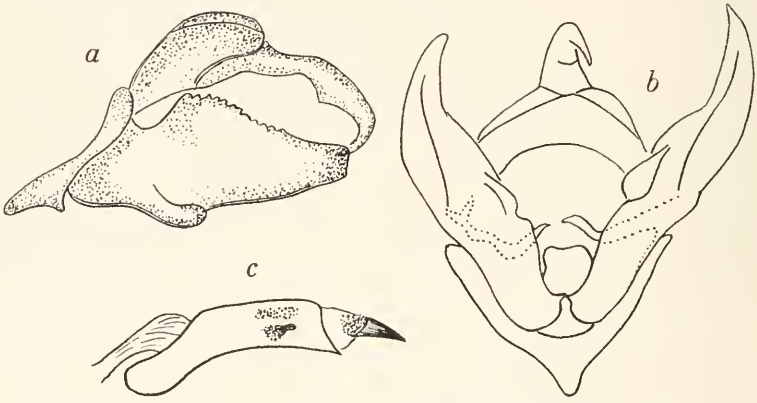

Fig. 4. Male genitalia of *Caeneressa klapperichi,* new species; preparation no. S.046 (M.K.).
a, lateral view; *b,* ventral view; *c,* aedoeagus.

Range. The species is known from the above locality only.

Remarks. The appearance of this new species is very like that of *pratti* Leech and *proxima,* n. sp.; *klapperichi* is especially closely related to the first of these species. It is likely that *klapperichi* may be a geographical subspecies of *pratti,* but in view of our scanty knowledge of both at present, it is better to consider them provisionally as two independent species. Superficially both are distinctive in the coloring of the frons and patagia, also in a dissimilar pattern of the abdomen. The distinguishing features in the male genitalia are given in the *pratti*

description. As to the distinction between *klapperichi* and *proxima*, refer to the remarks on this latter species.

3. Caeneressa pratti (Leech, 1889), new combination

Pl. 1, figs. 4, 5

Syntomis pratti Leech, 1889, Trans. Ent. Soc. London, p. 123, pl. 9, fig. 3; 1898, *ibid.*, p. 325; Hampson, 1898, Cat. Lep. Phal., **1**, p. 64; Seitz, 1909, Gross-Schm. Erde, **2**, p. 40; Zerny, 1912, Wagner's Lep. Cat., **7**, p. 25; Wu, 1938, Cat. Ins. Sin., **4**, p. 632. — ORIGINAL DESCRIPTION: "Allied to *Syntomis muirheadii*, Feld., to which species it bears a strong superficial resemblance, but is separated therefrom by having only two hyaline spots towards base of primaries, and blackish margins to abdominal fold of secondaries. There is no yellow patch on the posterior edge of thorax, but one is situated band-like on first segment of abdomen, and this is followed by five yellow belts in the male and four in female. These last are interrupted on the back of the female by a stripe of the blackish ground colour. Antennae strongly pectinated in the male, a character which at once distinguishes it from male *S. muirheadii*. Expanse, ♂ 47 mm., ♀ 56 mm." (Leech, 1889).

Zygaena pratti Kirby, 1892, Synon. Cat. Lep. Het., **1**, p. 95.

Male. Antennae bipectinate, black, the apical half of the shaft white. Head black; frons white. Patagia and tegulae yellow, the latter bordered with black. Thorax black; pectus with two yellow patches on each side. Legs concolorous with the body or slightly paler; the interior side of the fore coxae yellowish white, the base of the tarsi whitish. Abdomen brownish black; the entire first tergite orange-yellow; second segment with orange-yellow, lateral patches on the tergite and a similarly colored, complete, postsegmental band on the sternite; third to sixth segments (incl.) with complete, orange-yellow, postsegmental girdles, paler on the ventral surface. Wings brownish black, spots white-hyaline. Length of the forewing: 23 mm.

In the forewing a rather short, wedge-shaped spot (m_2) at the end of the middle cell; an elongate spot (m_{1+3}) below it reaches about to a point on a level with the middle of the middle cell spot; a rather narrow, elongate spot (m_4) between the veins R_5 and M_1 accompanied by two short, hyaline streaks above and beneath; two shorter but broader, egg-shaped spots (m_5 and m_6) between the veins M_2 and Cu_1 separated from

each other by the black vein M_3; the upper of these spots is slightly longer than the lower one.

The hindwing with a large basal spot which begins in the middle cell and extends almost to the dorsum; a smaller distal spot separated from the basal spot by a transverse black bar and divided by the black vein Cu_1 into two unequal parts.

Female. Similar to the male. Antennae serrate. Frons greyish white. Patagia black, yellowish at sides. First tergite of the abdomen orange-yellow, second to fifth tergites (incl.) with similarly colored, broad lateral patches; the corresponding sternites with paler yellow postsegmental bands. The subcostal area of the forewing whitish hyaline. Length of the forewing: 26-28 mm.

Male Genitalia (Pl. 1, fig. 6). Like those of *klapperichi,* n. sp., but the valvae tips strongly curved inward. Fultura inferior more elongate. The distal cornutus narrower but more dilated at the base; the proximal cornutus slightly longer than in *klapperichi.*

Types. Holotype, male, and allotype, female, Kiukiang, Province Kiangsi, June, 1887 A. E. Pratt (genitalia preparation of the holotype no. 221; B.M.).

Additional material examined. One female, Province Kiangsi, June 15 (A.M.N.H.).

Range. Chinese province of Kiangsi.

Remarks. Very similar to both preceding species whose distinguishing features are discussed above. The resemblance of *pratti* to *diaphana* Koll. ssp. *muirheadii Fldr.* with which this species has been compared by Leech (1889) is very remote and neither can be mistaken for the other. The hyaline wing spots in *muirheadii* occupy a larger surface, the supplementary elements of the markings are more developed, the abdominal girdles more numerous. In addition to these differences and those in the male genitalia, the antennae of *muirheadii* are serrate in the male and simple in the female.

4. Caeneressa obsoleta (Leech, 1898), new status and combination

Pl. 2, figs. 7-9

Syntomis swinhoei ab. *obsoleta* Leech, 1898, The Entom., **31**, p. 152. — ORIGINAL DESCRIPTION: "In this form the upper hyaline spot of the

subapical trio is absent, and also the spot between the interno-median bar and the two submarginal spots; the border of secondaries is broader. Expanse, 34 millim." (Leech, 1898).

Syntomis actea ab. *obsoleta* Zerny, 1912, Wagner's Lep. Cat., **7**, p. 19; Seitz, 1913, Gross-Schm. Erde, **10**, p. 74.

Male. Antennae bipectinate, black, one-fourth white-tipped. Head and patagia entirely black; tegulae yellow with black end-hairs. Thorax black with a large, yellow, posterior patch; pectus with a faint-yellow patch on each side. Legs black, the interior surface of the coxae yellow. Abdomen violet-black; first tergite yellow, at the middle broadly interrupted by black; yellow, post-segmental bands on second to seventh segments (incl.), enlarged medio-dorsally and ventro-laterally, sometimes absent on fifth and sixth sternites. Wings black, spots white-hyaline. Length of the forewing: 17-19 mm.

In the forewing a long, wedge-shaped spot (m_2) in the middle cell; below it a long, more or less broad, slightly arched spot (m_{1+3}) which extends from near the wing base to about three-fourths of the dorsum; an elongate-ovate spot (m_4) above the base of the vein M_1, accompanied by a small, slightly elongate extra spot below this vein, and sometimes also by a little dot above the base of the vein R_5; two spots (m_5 and m_6) in the interspaces of the veins M_2 and Cu_1, egg-shaped, dilated toward outside, the lower of them slightly broader and longer, separated from each other by the black vein M_3; sometimes a little, ovate, extra spot above the base of the vein Cu_2.

The hindwing spots form a common hyaline area bordered by black; these borders are broad at the costa, dilated at the apex, with an obtuse tooth at the vein A_2.

Female. Similar to the male but with antennae serrate. The eyes circumciliated with yellow. The interior surface of the coxae black. First abdominal tergite with two yellow, lateral patches and a similarly colored streak at the middle; second to sixth segments (incl.) with yellow bands dilated medio-dorsally and ventro-laterally, the two posterior ones sometimes reduced or absent.

Male Genitalia (Fig. 5). Tegumen moderately arched; uncus long, undulate, with a short tip curved downward; saccus long, narrow. Valvae symmetrical; sacculus large, thickened, with a round tip; upper edge of the valva almost straight; an acute

projection between it and the irregularly concave distal edge; valva tip truncate, with a prolonged, acute, distal angle; processus basales extend to the vallum penis, their tips dilated. Fultura inferior elongate. Aedoeagus slender and long, slightly curved downward at coecum penis and upward at the tip; a single, grain-shaped cornutus.

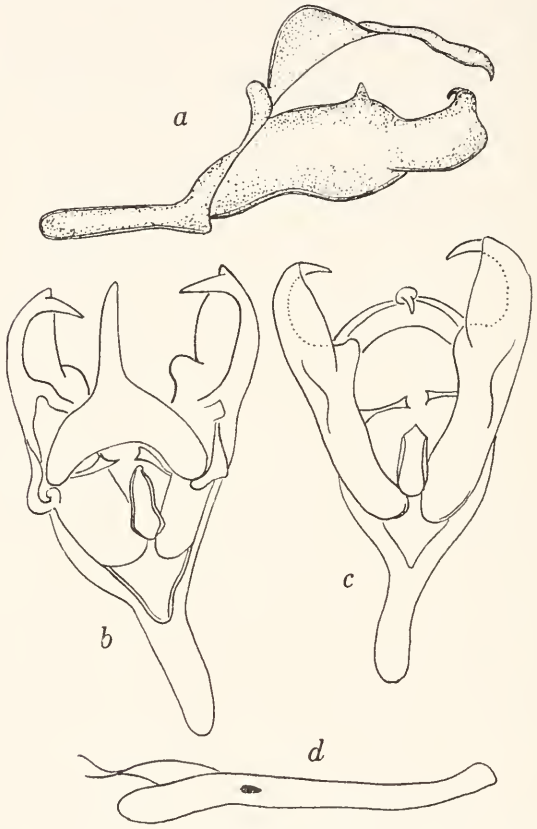

Fig. 5. Male genitalia of *Caeneressa obsoleta* (Leech); preparation no. S.049 (Z.C.M.).
a, lateral view; *b*, dorsal view; *c*, ventral view; *d*, aedoeagus.

Type. Holotype, female, Ningpo, Province Chekiang, July, 1886 (B.M.).

Additional material examined. Two males and four females, Kuatun, Province Fukien, 2300 m.alt., May 19 till June 11, 1938, J. Klapperich (M.K.); one male and one female, the same data (preparation of the male genitalia no. S.049; Z.C.M.).

Range. Chinese provinces of Chekiang and Fukien; Chusan Islands.

Variation. The nominate form of the species was described as having a single extra-spot below the forewing spot m_4. Most of the specimens examined from Kuatun are like the type, others have extra spots above and beneath the spot m_4. Sometimes another extra spot, on the outer side of the forewing spot m_{1+3} is present. A male specimen from Kuatun (May 20, 1938) lacks extra spots completely.

Remarks. This species was established by Leech as an aberration of *swinhoei* Leech and considered by later authors as belonging to *actea* Swinh. but it has nothing to do with either of these species. It bears rather some likeness to *proxima,* n. sp., but is much smaller and with no spot on the frons, has dissimilar markings of the abdomen and very distinct genitalia.

5. Caeneressa swinhoei (Leech, 1898), renewed status and new combination

Pl. 2, figs. 4, 5

Syntomis swinhoei Leech, 1898, The Entom., **31**, p. 152; 1898, Trans. Ent. Soc. London, p. 322. — ORIGINAL DESCRIPTION: "Allied to *S. actea*, Swinh., but the frons and head are black; the fronts of the tegulae and the metathorax are marked with yellow. The abdomen of male has seven yellow bands, and that of the female six. On the primaries the black along fifth vein between the discal bar and marginal border is narrower, as also is the marginal border of secondaries. Expanse, ♂ 35 millim., ♀ 36 millim." (Leech, 1898).

Syntomis actea ssp. 1 Hampson, 1898, Cat. Lep. Phal., **1**, p. 64.

Syntomis actea ssp. *swinhoei* Hampson, 1898, *op. cit.*, p. 537; Seitz, 1909, Gross-Schm. Erde, **2**, p. 40; 1913, *op. cit.*, **10**, p. 74; Zerny, 1912, Wagner's Lep. Cat., **7**, p. 19; Wu, 1938, Cat. Ins. Sin., **4**, p. 629.

Amata actea swinhoei Fletcher, 1925, Cat. Ind. Ins., **8**, p. 7.

Male. Antennae bipectinate, black, presumably white tipped (in the holotype the antennae tips are broken). Head entirely black. Patagia black, yellow laterally; tegulae yellow with black end-hairs. Thorax black with a large, yellow, posterior patch;

pectus with yellow, lateral patches. Abdomen black; first tergite with yellow lateral patches; second to seventh segments (incl.) with yellow postsegmental bands. Wings hyaline with veins and borders black, the latter enlarged at the apex. Forewing, moreover, with a black, subquadrate discal spot and a black ray along the vein M_2 from the discal spot to the black wing borders; these latter with a truncate tooth between the veins Cu_1 and Cu_2; subcostal and supradorsal areas black. Hindwing with the subcostal area and the middle cell black. Length of the forewing: 16 mm.

Female. Similar to the male but antennae serrate, black, white tipped. Abdomen with the first tergite patched not only laterally but also with presegmental and postsegmental yellow patches at the middle; all yellow abdominal bands dilated at the middle; seventh segment without any band. Length of the forewing: 17 mm.

Male Genitalia (Pl. 2, fig. 6). Like those of *hocnei* (cf. below), but differing from them as follows: Tegumen broader; uncus with a more curved tip. Both valvae almost equally long; the lower distal angle of the left valva stout, the upper angle directed more upward; in the right valva the upper distal angle more acute.

Types. Holotype, male, Mupin, Province Szechwan, June, Kricheldorff (preparation of genitalia no. 223; B.M.); allotype, female, Chiatingfu, Province Szechwan, July, A. E. Pratt (B.M.).

Range. Chinese province Szechwan.

Remarks. The acquaintance of the author with this species is based on photographs of the type specimens in the British Museum and the male genitalia of the holotype; certain characters of the markings of those specimens were verified by Mr. S. G. Kiriakoff at the author's request.

This species was considered by Hampson (1898) as a subspecies of *actea* Swinh., while in point of fact *swinhoei* differs from *Caeneressa actea* (Swinh.) (Pl. 2, figs. 1-3) both superficially and in the male genitalia. The frons of *actea* is yellow in the female; the eighth abdominal segment of the male (seventh of the female) is yellow; in *swinhoei* it is black. The male genitalia of *actea* are very typical: uncus deeply undulate, gibbous before a rather narrow and long tip; saccus rather short; the right valva with the lower distal angle pointed and the upper

angle broadly rounded, underdeveloped; the left valva much narrowed distally, with an almost straight, sharply pointed lower distal angle. Aedoeagus of *actea* is shorter and thicker than in *swinhoei*.

For a discussion of distinguishing features of very similar *hoenei, dispar* and *zernyi*, refer below to the descriptions of these species.

6. Caeneressa hoenei, new species

Pl. 1, figs. 9, 10

Male. Antennae bipectinate, black, the apical part of the shaft white. Head black; frons yellow. Patagia black; tegulae yellow with black end-hairs. Thorax black with a posterior yellow patch; pectus with two yellow patches on each side. Legs concolorous with the body; the interior side of the coxae entirely yellow. Abdomen black; first tergite with lateral yellow patches; yellow postsegmental bands (dilated on the ventral side) on the following six segments; the tip of the abdomen black with bluish-violet gloss.

Wings hyaline with black veins and narrow (at the apex dilated) black borders. In the forewing a black, subrectangular discal patch; the vein M_2 connecting this patch with the wing border black scaled; a broad, truncate tooth on the interior side of the black wing border between the veins Cu_1 and Cu_2; subcostal and supradorsal areas of the forewing black. Hindwing with very narrow black borders slightly dilated at the apex. Reverse of both wings with a strong yellowish scaling along the costa and the dorsum, on interior edges of the black wing borders, partly also along the veins. Length of the forewing: 15-19 mm.

Female. Similar to the male. Antennae serrate. Head entirely black. Coxae of all legs yellow streaked. Yellow bands, narrower on the ventral side, on second to sixth abdominal segments (incl.).

Male Genitalia (Fig. 6). Tegumen elongate, moderately arched; uncus long, equally curved; saccus long and rather narrow. Valvae asymmetrical, the right one longer; upper and distal edges not differentiated from one another; the distal part of the valva subrectangular, with a truncate-concave edge and

upper and lower angles both acute and longer on the right valva; sacculus long and wide; processus basales narrow, dilated at tips. Vallum penis with two lateral dentate plates joined to the tips of processus basales. Fultura inferior rounded, inversely heart-shaped. Aedoeagus slender and very long, slightly curved downward at the coecum penis and upward at the tip; a single, thorn-shaped cornutus.

Types. Holotype, male, Tapaishan in Tsinling, Province Shensi, 1700 m.alt., July 7, 1936; allotype, female, of the same locality and date; three male paratypes taken July 7 to 10, 1936, H.

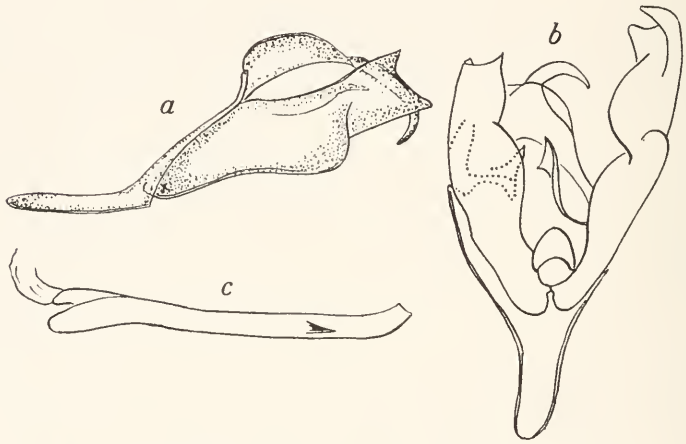

Fig. 6. Male genitalia of *Caeneressa hoenei,* new species; preparation no. S.047 (Z.C.M.).
a, lateral view; *b,* ventral view; *c,* aedoeagus.

Höne (M.K.). A further male paratype from the same locality (preparation of genitalia no. S.047; Z.C.M.).

Range. The species is known from the above locality only.

Remarks. From *swinhoei* Leech to which the new species is closely related, it differs in having black patagia and a yellow frons in the male. *C. hoenei* also resembles *actea* Swinh., *dispar* n. sp. and *zernyi* n. sp. but in *actea* the frons is black in the male, yellow in the female, and the patagia and the anal abdominal segments are yellow. Both sexes of *dispar* have entirely yellow head and patagia, and the yellow abdominal bands are almost

joined together; *zernyi*, in which the female is unknown, has an entirely black head. The genitalia of all these species are unlike those of *hoenei*.

7. Caeneressa dispar, new species

Pl. 4, figs. 1, 2

Male. Antennae bipectinate, dark brown, the two apical thirds of their shafts yellowish. Head, patagia, and tegulae yellow. Thorax brownish black with a posterior yellow patch; pectus with two yellow patches on each side. Legs brownish, diffusely yellow scaled. Abdomen black; first tergite with a yellow rectangle, black patched in the middle; second to seventh segments (incl.) with postsegmental yellow bands joined at the middle line, each of the tergites consequently with two dorsolateral black patches; eighth tergite black postsegmentally with yellow hairs; sternites whose scaling is very damaged may presumably be entirely yellow.

Wings hyaline, veins and narrow borders (dilated at the apex) brownish black. Forewing, moreover, with a brownish-black discal patch; vein M_2 rather more blackish scaled, supradorsal area black; subcostal area with longitudinal hyaline streak. Costa of the hindwing broad black; upper part of the middle cell hyaline. Length of the forewing: 16 mm.

Female. Similar to the male from which it differs as follows: Antennae serrate, with short, yellowish-white tips. Head black; frons, cheeks and vertex diffusely yellow scaled. Legs black. Abdomen with bands as in the male but on first to sixth tergites (incl.) only; the joining of bands not so clear; anal segments and all sternites black. The black pigmentation of the body more intensive and the yellow markings more orange. Black markings more dilated in both wings, and the black forewing borders with a distinct, broad tooth at the vein Cu_2. Length of the forewing: 18-19 mm.

Male Genitalia (Fig. 7). Tegumen with two lateral appendages curved upward; uncus rather long, moderately curved; saccus rather long. Valvae short, almost symmetrical; saceulus narrow; the terminal part of the valva much narrower than the basal part; the upper distal angle slightly acute; processus basales

straight, extending to the vallum penis. Fultura inferior elongate-ovate, with a concave upper edge. Aedoeagus comparatively large, slightly curved; three thorn-like cornuti.

Types. Holotype, male, Kuatun (27°40′ N. and 117°40′ E.), Province Fukien, 2300 m. alt., May 19, 1938, J. Klapperich (genitalia preparation no. S.048; M.K.); allotype, female, the same locality, May 6, 1938, J. Klapperich (M.K.); paratype, female, April 25, 1938, the same locality and collector (Z.C.M.).

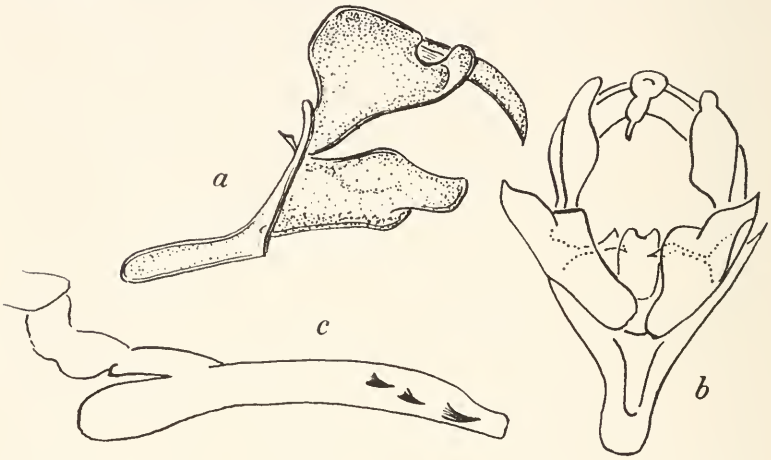

Fig. 7. Male genitalia of *Caeneressa dispar,* new species; preparation no. S.048 (M.K.).
a, lateral view; *b,* ventral view; *c,* aedoeagus.

Additional material examined. Female, Shanghai, Province Chekiang, H. Höne (M.K.).

Range. Chinese provinces Fukien and Chekiang.

Remarks. The similarity of both sexes in certain characters and the fact that the moths were found in the same locality within a comparatively short time period, argues in favor of considering them conspecific. If this is not the case, the female may be considered as a new species because it is unlike any other known species.

The female specimen from Shanghai has an abdominal pattern like that in the male holotype; in the rest of its characters it

does not differ from the Kuatun females except that the black wing markings are rather more developed and some of the hyaline areas are more spot-like.

Some similarity exists between *dispar* and *actea* Swinh., *swinhoei* Leech, and *zernyi* n. sp., but all these species have their abdominal bands free, not joined. The male genitalia and some other characters in the above species are unlike those of *dispar*. The male of *dispar* recalls slightly the Formosan *Amata karapinensis* (Strd.) but the latter is not a *Caeneressa* species.

8. Caeneressa zernyi, new species

Pl. 4, fig. 3

Male. Antennae bipectinate, black, the apical third of their shafts white. Head, patagia, and thorax black; tegulae yellow with black end-hairs. Legs brown. Abdomen black with the first tergite orange patched (the scaling of the remaining abdominal segments is damaged, and only some orange scales indicate that bands were originally present).

Wings hyaline with veins and borders black. Forewing with a subquadrate, black discal patch; a black ray along the vein M_2 joins the discal patch with the dilated apical border; a truncate interior tooth of the black wing border between the veins Cu_1 and Cu_2; subcostal and supradorsal areas black. Hindwing with black borders dilated at the apex; costa and the middle cell black. Length of the forewing: 16 mm.

Male Genitalia (Fig. 8). Tegumen scarcely developed; uncus very long, curved, dilated at the base and before the narrow, rounded tip; (the saccus is missing). Valvae symmetrical; sacculus well developed, broad, rather flat; the upper edge of the valva almost straight to the distal angle; the apical part of the valva narrow and elongate; processus basales much longer than the vallum penis, curved, arranged caudad. Fultura inferior irregularly shaped, narrow in the upper part and dilated in the lower. Aedoeagus slender, moderately long, slightly curved, with a moderate coecum penis; a single, thorn-shaped cornutus.

Type. Monotype, male, Shinchow near Canton, Province Kwangtung (genitalia preparation no. S.008; Z.C.M.).

Remarks. This species was identified by Dr. H. Zerny (Vienna)

as new but was not described. It is superficially similar to *actea* Swinh., *swinhoei* Leech and *dispar* n. sp. but differs from them in the black patagia. From *hoenei* n. sp. it differs in having an entirely black head. The peculiar processus basales and the uncus of *zernyi* are unlike those of the remaining known *Caeneressa* species.

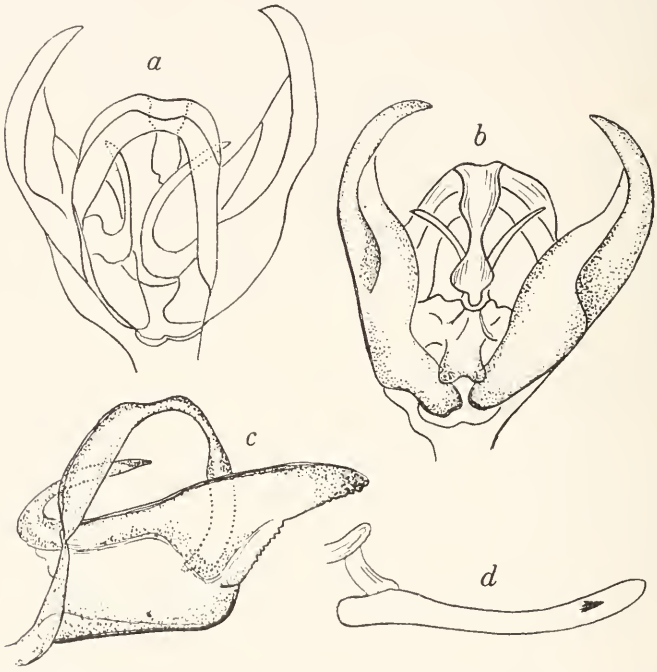

Fig. 8. Male genitalia of *Caeneressa zernyi,* new species; preparation no. S.008 (Z.C.M.).
a, dorsal view; *b,* ventral view; *c,* lateral view; *d,* aedoeagus.

9. Caeneressa ningyuena, new species

Pl. 4, fig. 4

Female. Antennae deeply serrate, black, one-fourth white tipped. Head red; a narrow streak between the eyes and the mouth parts, black. Patagia entirely red; tegulae red with

brownish-black end-hairs. Thorax black with a posterior red patch; pectus with two red patches on each side. Legs entirely black. Abdomen black with six broad, red, postsegmental bands on first to sixth tergites (incl.).

Wings hyaline with black veins and borders. Forewing with the borders broadly dilated at apex and forming a broad, interior tooth at the vein Cu_2; a broad, black discal spot sending a ray along the vein M_2 to the border; subcostal and supradorsal areas rather diffusely black scaled. Hindwing borders narrow, dilated only at the apex; costa and the greatest part of the middle cell black. Length of the forewing 15 mm.

Type. Monotype, female, mountains near Ningyuenfu, Province Szechwan (Z.C.M.).

Remarks. Because of its red pigmentation, *ningyuena* may be compared with *rubrozonata* Pouj. to which it has no other similarity. The female of *rubrozonata* has simple antennae; only its frons, not the whole head, is red; the red pigmentation on the tegulae and the pectus is less developed, the thorax is entirely black. Also the postsegmental edge of the seventh abdominal sternite is distinct in both species (Fig. 12). From *graduata* Hmps., also red-pigmented, *ningyuena* can be distinguished by its broader forewing shape, less developed black wing markings, and absence of the longitudinal red lines on the abdomen. The antennae of *graduata* are simple in the female.

10. Caeneressa oenone (Butl.), new combination and renewed status

Syntomis diaphana var. ? Walker, 1854, List. Spec. Lep. Ins. B. M., **1**, p 126. — ORIGINAL DESCRIPTION: "Nigro-viridis, flavo varia; antennae nigrae serrate, apice albae; alae hyaline subluridae, purpureo-fusco marginatae, anticae purpureo-fusco fasciatae. Blackish green. Head pale yellow; vertex black. Proboscis tawny. Antennae black, serrated along the whole length, white above towards the tips. Thorax with an interrupted yellow band in front, and with a large subtriangular yellow mark on each side; scutellum and pectus mostly yellow. Wings hyaline, with a slight lurid tinge; borders, band on the tip of the discal areolet, and an opposite mark on the hind border purplish brown. Abdominal segments with more or less interrupted yellow bands. Legs blackish brown. Length of the body 6 lines: of wings 14 lines." (Walker, 1854).

Syntomis oenone Butler, 1876, J. Linn. Soc. London, Zool., **12**, p. 344; Swinhoe (and Cotes), 1887, Cat. Moths Ind., p. 49. — ORIGINAL DESCRIPTION: "*S. diaphana*, var. ?, Walker (*nec* Kollar) is a distinct species, and may be named *S. oenone.*" (Butler, 1876).

Zygaena vitreata (part.) Kirby, 1892, Synon. Cat. Lep. Het., **1**, p. 95.

Syntomis diaphana (part.) Hampson, 1892, Fauna Brit. India, Moths, **1**, p. 216; 1898, Cat. Lep. Phal., **1**, p. 67; Seitz, 1909, Gross-Schm. Erde, **2**, p. 40; Zerny, 1912, Wagner's Lep. Cat., **7**, p. 20.

Antennae shortly bipectinate in the male, serrate in the female. In other respects, this species cannot be distinguished from *C. diaphana* (Koll.).

Male Genitalia. Uncus rather longer than in *diaphana*, with a more prolonged and acute tip; saccus larger; valvae somewhat broader. Fultura inferior almost regular ovate.

Type. Holotype, male, North India (B.M.).

Additional material examined. Five males and five females, Kooloo, Himalaya, Carleton (preparation of male genitalia no. 1, Obr.; M.C.Z.).

Range. Western Himalaya.

Remarks. Although this species has been not found within the limits of China, its presence in the Western Himalaya and a great similarity to *diaphana* Koll. are reasons for including it in the present revision. Walker (1854) described the antennae of *oenone* as "serrated along the whole length." This is an evidence that he correctly distinguished between *oenone* and *diaphana*. The later authors neglected this feature and ranked *oenone* to *diaphana*. As matter of fact, the antennae of *oenone* are shortly bipectinate in the male, but without a good magnifier seem serrate; those of *diaphana* seem, under the same conditions, simple, and Hampson (1898) therefore placed this moth among the species with antennae simple in both sexes.

The series of the *oenone* moths examined at the Museum of Comparative Zoology, represent specimens with markings like those of the nominotypical subspecies of *diaphana*. It is very significant that one *diaphana* female specimen was also caught in Kooloo.

11. Caeneressa diaphana (Koll.), new combination

The synonymy is given under subspecies.

Male. Antennae serrate, black, apical part of the shaft white

above. Head black; frons and narrow streaks behind the eyes white, cream-white, yellow or orange. The ground of the whole body black, often with a greenish, violet, or bronze reflection. Patagia from cream-whitish to orange, in the middle usually divided by black; tegulae concolorous with the patagia, with black end-hairs. Thorax with a broad transversal, whitish, yellow or orange, posterior patch; this patch is often divided into two patches; the middle part of the thorax sometimes with two longitudinal, concolorous lateral streaks; pectus with two similar patches on each side. Legs black or dark brown, often with a bronze or greenish reflection; sometimes the femora and tibiae with whitish or yellow longitudinal streaks, and the inner surface of the coxae is of the same color; first joint of the tarsi sometimes whitish. Abdomen with whitish, yellow or orange bands on seven segments; at least some of these bands dorsally narrowed or interrupted at the middle; some of the anterior bands often paler than the remaining bands; on the ventral side the bands are usually somewhat paler; the anal segment black or yellow.

Wings predominantly hyaline with black veins and borders. In the forewing these borders are always dilated at the apex, usually more or less dilated at the vein M_2 and between the veins Cu_1 and Cu_2; discocellulars with a more or less broad, black spot; along the vein M_2 usually a black ray joining the discal spot with the wing borders. All these black markings are variously developed, and the hyaline area is sometimes reduced to separate spots: a long spot (m_{1+3}) below the middle cell extends nearly from the wing base to the tornus; a wedge-shaped spot (m_2) in the middle cell; a more or less large extra spot above the base of the vein Cu_2; three larger, elongate spots (m_4 to m_6), between the veins R_5 and M_1 and M_3 and Cu_1 form (together with two smaller and narrower extra spots above and beneath the spot m_4) an exterior row of forewing spots. The basal parts of the forewing veins often yellow. In the hindwing the black borders dilated at the apex and slightly indented at the vein Cu_2; the middle cell locked by a black discal spot. A stronger development of the black markings may make two spots of the whole hyaline area of the hindwing; they are almost separated from each other by the vein Cu_2. Middle cell and dorsum of the hindwing often whitish or yellowish scaled. Length of the forewing: 15-25 mm.

Female. Similar to the male. Antennae simple. Abdomen with six whitish or orange bands. Length of the forewing: 17-30 mm.

Male Genitalia (Fig. 1). Tegumen elongate, arched; uncus long, curved, dilated toward the tip and then pointed; in the dorsal view the uncus is equally narrowed from the base to the tip; saccus broad, short. Valvae almost symmetrical, or the left valva is somewhat shorter, both leaf-shaped; sacculus moderately thickened; distal edge of the valva more or less dentate; processus basales extend to the vallum penis. Fultura inferior rounded. Aedoeagus moderately thickened, slightly curved at the middle; coecum penis moderate, broadly rounded; cuneus composed of numerous, diffusely arranged, small, sclerotized cones and a plate on the vesica.

Female Genitalia (Fig. 2). Discussed in the description of the genus.

Range. From Kashmir and North India through most of China and Indo-China to the Great Sunda Islands; Formosa.

Remarks. In the limits of its range, this species is found in three subspecies. They have no difference in the genitalia and are linked together by intermediate forms.

11a. Caeneressa diaphana diaphana (Koll.), new status

Pl. 3, figs. 1-4

Syntomis diaphana Kollar, 1848, Hügel's Kaschmir, **4**, part 2, p. 460, pl. 19, fig. 7; Walker, 1854, List. Spec. Lep. Ins. B. M., **1**, p. 126; Herrich-Schäffer, 1858, Samml. neuer oder wenig bek. aussereurop. Schmett., p. 72; Swinhoe (and Cotes), 1887, Cat. Moths Ind., p. 47; Hampson, 1892, Fauna Brit. India, Moths, **1**, p. 216; Swinhoe, 1895, Trans. Ent. Soc. London, p. 31; Hampson, 1898, Cat. Lep. Phal., **1**, p. 67; Snellen en Piepers, 1904, Tijdschr. v. Ent., **47**, p. 51, 53; Seitz, 1909, Gross-Schm. Erde, **2**, p. 40; Zerny, 1912, Wagner's Lep. Cat., **7**, p. 20; Seitz, 1913, *op. cit.*, **10**, p. 74, pl. 9g [fig. 4]. — ORIGINAL DESCRIPTION: "Alis diaphanis, marginibus, macula in anticis costali nervisque nigris; fronte, maculis humeralibus, metathoracis cingulisque abdominis, medio interruptis, flavis. Expans, alar. 1", 8‴ (mas.) — 2", 1½‴ (femin.)." "Die grösste mir bekannte, sehr ausgezeichnete Art. Die Flügel alle glashell, durchsichtig, nur ihre Ränder und die Adern schwarz. Auf den Vorderflügeln erstreckt sich an der Spitze die schwarze Färbung am weitesten nach innen, dann verbindet beiläufig in der Mitte ein schwarzer Fleck die beiden Hauptäste der Flügeladern,

und entsendet einen schmalen Streifen nach der Spitze hin; auch vom Aussenrande, nahe am hinteren Winkel wird der schwarze Saum breiter. Die Adern sind verhältnismässig dick. Die schwarze Einsäumung der Hinterflügel ist ziemlich gleichförmig und das durchsichtige Feld nur von drei feinen Adern durchzogen. Die Stirne, beiderseits ein Schulterfleck, ein in der Mitte unterbrochener Querstreifen am Hinterrücken gelb, auch der Hinterleib erscheint mit sieben in der Mitte unterbrochenen, beim Manne ockergelben, beim Weibchen mehr lichtgelben Ringen. Die Fühler sind schwarz, gegen die Spitze weiss bestäubt.'' (Kollar, 1848).

Syntomis vitreata Herrich-Schäffer, 1855, Samml. neuer oder wenig bekannt. aussereurop. Schmett., pl. 50, fig. 267. There exists no description of *vitreata*, only a figure has been published. In the text accompanying the plates, Herrich-Schäffer considered this name as synonymous with *diaphana* Koll. to which the figure of *vitreata* has an undoubted similarity.

Hydrusa baiaea Swinhoe, 1891, Trans. Ent. Soc. London, p. 473, pl. 19, fig. 10; Kirby, 1892, Synon. Cat. Lep. Het., **1**, p. 902; Hampson, 1892, Fauna Brit. India, Moths, **1**, p. 222; Swinhoe, 1895, Trans. Ent. Soc. London, p. 32. — ORIGINAL DESCRIPTION: ''♂ ♀. Palpi and antennae black, antennae white above towards the tips; frons, head, and body bright ochreous; space between the antennae, a thin band behind, three longitudinal stripes on thorax, which meet in a band before and behind, segmental bands on abdomen, and extreme tip, deep black. Wings mostly hyaline, with black veins and borders. Fore wings with the costal line black, the band on disco-cellular broadly black, the black colour on the lower discoidal veinlet and on the first and second median veinlets thickening towards the irregular marginal band, some ochreous colour on the veins towards the base and on the space below the submedian vein. Hind wings with the costa broadly black, and with a marginal band somewhat as on fore wings. Under side as above; legs black, streaked with ochreous grey; tarsi for the greater part whitish. Expanse of wings, 1⅙ in.'' (Swinhoe, 1891). NEW SYNONYM.

Hydrusa diaphana Swinhoe, 1892, Cat. East. and Austral. Lep. Het., **1**, p. 51.

Zygaena diaphana Kirby, 1892, Synon. Cat. Lep. Het., **1**, p. 95.

Zygaena vitreata Kirby, 1892, *op. cit.*, p. 95.

Syntomis baiaea Hampson, 1897, J. Bombay N. H. Soc., **11**, p. 284; 1898, Cat. Lep. Phal., **1**, p. 67; 1900, J. Bombay N. H. Soc., **13**, p. 47; Seitz, 1913, Gross-Schm. Erde, **10**, p. 74, pl. 9f [fig. 9].

Syntomis muirheadi (*non* Fldr.) Hampson, 1898, Cat. Lep. Phal., **1**, pl. 3, fig. 13; Sonan, 1941, Trans. N. H. Soc. Formosa, **31**, p. 96.

Syntomis horishana Matsumura, 1911, Thousand Ins. Jap., Suppl., **3**, p. 69,

pl. 35, fig. 19; Wileman, 1929, Trans. Ent. Soc. London, **76**, p. 429; Matsumura, 1931, 6000 Illustr. Ins. Jap., p. 995, fig. — ORIGINAL DESCRIPTION: "♀. Fore wing yellowish, hyaline in certain lights reflecting blue; costa, outer and hind margin, a spot upon the cross vein, a longitudinal stripe each upon the veins III and V, as well as the total veins dark brown; at the hind margin with a yellow stripe. Hind wing just like the fore wing, veins except II yellowish, costa and outer margin as well as the vein II dark brown. Body dark brown, frons, collar, tegulae, mesonotum in the middle, a broad band to each segment of the abdomen and pygidium yellow. Legs dark brown, tarsi somewhat paler. Length: 16 mm.; exp. 48 mm." (Matsumura, 1911). NEW SYNONYM.

Syntomis hoppo Matsumura, 1911, Thousand Ins. Jap., Suppl., **3**, p. 70, pl. 35, fig. 20; Wileman, 1929 Trans. Ent. Soc. London, **76**, p. 431; Matsumura, 1931, 6000 Illustr. Ins. Jap., p. 995, fig. — ORIGINAL DESCRIPTION: "It differs from *S. horishana* m. as follows: ♀. 1. Hyaline spot of the cell 1b somewhat narrower. 2. Veins of the hind wing dark brown. 3. Frons, collar, tegulae orange yellow. 4. Abdomen orange yellow, to each segment with a spindle shaped black band, 2 last segments black, shot with blue. Length: 16 mm.; exp. 48 mm." (Matsumura, 1911). NEW SYNONYM.

Syntomis bajaca Zerny, 1912, Wagner's Lep. Cat., **7**, p. 19.

Amata baiaca Fletcher, 1925, Cat. Ind. Ins., **8**, p. 8.

Amata diaphana Fletcher, 1925, *op. cit.*, p. 11; Candèze, 1927, Enc. Ent., ser. B, Lepidoptera, **2**, p. 74; Joannis, 1928, Ann. Soc. Ent. France, 97, p. 245.

Syntomis muirheadi ab. *horishana* Kawada, 1934, Cat. Ins. Jap., **5**, Lep. Syntomidae, p. 2.

Syntomis muirheadi ab. *hoppo* Kawada, 1934, *loc. cit.*

Wings mostly hyaline with the black only on their borders, discocellulars, and other veins. The hyaline areas separated by veins and merely by a black ray along the forewing vein M_2. The interior tooth of the forewing terminal border between the veins Cu_1 and Cu_2 never meets the middle-sized discocellular patch and just along these veins reaches sometimes to the middle cell. Patagia yellow; thorax with or without longitudinal yellow streaks; yellow abdominal bands interrupted at the middle, at least on two basal tergites.

Types. Syntomis diaphana: Holotype, male, and allotype, female, Masuri, N. W. Himalaya (location of types unknown); *Hydrusa baiaca:* holotype, male, Khasia Hills, Assam (B.M.); *S. horishana:* monotype, female, Horisha, Formosa (Hokkaido

Imperial University, Sapporo); *S. hoppo:* monotype, female, Hoppo, Formosa (the same collection).

Additional material examined. One female, Kooloo, Himalaya, Carleton (M.C.Z.); one female, Morendro Doonai, Shillong, Assam, 1936 (M.L.); two males (genitalia preparation no. S.002; Z.C.M.) and one female (Zoological Museum of the Kiev State University), Ningyuenfu, Province Szechwan; one female, Kiuhuashan, Province Anhwei, September, 1932, G. Liu (M.C.Z.); two females, Chiengmai, Siam, October 26-28, 1920 (A.M.N.H.); three males (A.M.N.H.) and one female (genitalia preparation no. Ct. 9; M.L.), Java; one male and one female, Tjibodas, Java, 1400-1800 m. alt., November 1-20, December, 1927, H. Burgeff (Z.C.M.); two males and two females, the same locality, April 1-10, 1907 (male genitalia preparation no. 2, Obr.; M.C.Z.); two males, Mt. Gede, Tjibodas, Java, April, 1909, Bryan and Palmer (genitalia preparation no. 4519 W.D.F.; U.S.N.M.); one male and one female, Gedeh, W. Java, 1350 m. alt., 1893; 1600 m. alt., 1887 (M.L.); one male, Sindinglaya, W. Java, 1885 (M.L.); one female, Preanger, W. Java, 5000 ft. alt., Sythoff (M.L.); one male, "Java Sea" (M.L.); two males (genitalia preparation no. Ct. 3; M.L.) and one female (M.C.Z.), without data.

Range. Kashmir; N. W. Himalaya; Chinese province Szechwan; S. China; from N. India to Burma; Indochinese Peninsula; Great Sunda Islands; Formosa.

Variation. The chief characters of the subspecies are more or less stable except for the width of the black wing borders and the yellow body pigmentation which may vary from specimen to specimen. All intermediate forms between the more yellow pigmented *baiaea* and the less yellow pigmented *diaphana* were found, and there is no necessity to separate these forms under special names. The same should be said of *horishana* and *hoppo* which are only synonyms for *diaphana.* The extreme individual forms are the following two.

ab. MELAS Wkr., new status (Plate 3, fig. 4)

Syntomis melas Walker, 1854, List. Spec. Lep. Ins. B. M., **1**, p. 133; Butler, 1877, Illustr. Het. B. M., **1**, p. 17, pl. 6, fig. 10; Swinhoe (and Cotes), 1887, Cat. Moths Ind., p. 49; Seitz, 1913, Gross-Schm. Erde, **10**, p. 73, pl. 9g [fig. 5]; Wileman, 1929, Trans. Ent. Soc. London, **76**.

p. 430, pl. 20, fig. 12. — ORIGINAL DESCRIPTION: "Purpureo-fusca, albido varia; proboscide fulva; palpis antennisque nigris, his apice albis; abdomen albido subinterrupte fasciatum; alae hyaline, longae, subluridae, marginalibus venisque infuscatis. Purplish brown. Head whitish in front, on each side and beneath. Proboscis tawny. Palpi and antennae black, the latter white above towards the tips. An interrupted band on the prothorax, four broad stripes on the mesothorax and scutellum whitish. Wings hyaline, long, with a very slight lurid tinge, bordered with brown round the margin and along the veins, especially at the tips and across the tip of the discal areolet and along the opposite space of the hind border; a whitish streak along the hind border of the fore wings, and another along the fore border of the hind wings. Abdomen nearly linear; segments from the first to the sixth with whitish bands which are partly interrupted above. Length of the body 10 lines; of the wings 28 lines." (Walker, 1854).

Zygaena melas Kirby, 1892, Synon. Cat. Lep. Het., **1**, p. 94.

Syntomis melaena (nom. emend.) Hampson, 1892, Fauna Brit. India, Moths, **1**, p. 216; Swinhoe, 1895, Trans. Ent. Soc. London, p. 31; Hampson, 1898, Cat. Lep. Phal., **1**, p. 96; 1900, J. Bombay N. H. Soc., **13**, p. 48; Zerny, 1912, Wagner's Lep. Cat., **7**, p. 23; Wu, 1938, Cat. Ins. Sinens., **4**, p. 630.

Amata melas Fletcher, 1925, Cat. Ind. Ins., **8**, p. 17; Joannis, 1928, Ann. Soc. Ent. France, **97**, p. 245.

Amata melaena Candèze, 1927, Enc. Ent., series B, Lepidoptera, **2**, p. 75.

Syntomis owstoni subsp. *melas* (ex err.) Wu, 1938, Cat. Ins. Sinens., **4**, p. 631.

Female specimens with the body pigmentation partly whitish instead of yellow, especially on the frons, patagia, tegulae, on the interior side of the fore coxae, and on the abdomen. Some of the abdominal bands are sometimes nevertheless yellow.

Type. Holotype, female, Nepal (B.M.).

ab. ANDERSONI Moore, new status (Plate 3, fig. 3)

Syntomis andersoni Moore, 1871, Proc. Zool. Soc. London, p. 244, pl. 18, fig. 1; 1878, *ibid.*, p. 845, 857; 1878, Anderson's Res. W. Yunnan, p. 296, pl. 81, fig. 4; Swinhoe (and Cotes), 1887, Cat. Moths Ind., p. 45. — ORIGINAL DESCRIPTION: "Male and female. Wings hyaline, veins bluish black; body black, with orange-yellow bands: fore wing with the costa and exterior and posterior margins black; space between the submedian vein and posterior margin pale yellow; a broad transverse discicellular black quadrate spot, which is recurved out-

wards: hind wing with the anterior border pale yellow, and having a small discoidal black spot; apex and exterior margin black; posterior margin tinged with yellow. Spot on front of head, coxae, legs above, and band on each segment of abdomen beneath white. Collar round thorax, tegulae, spots on thorax, and band on each segment of abdomen above orange-yellow; tip of abdomen in male purplish black, in female yellowish grey. Proboscis, palpi, antennae, and legs beneath black, the antennae tipped with white. Expanse, ♂ 1⁴⁄₁₀, ♀ 1¾ inch." (Moore, 1871).

Zygaena andersoni Kirby, 1892, Synon. Cat. Lep. Het., **1**, p. 96.

Syntomis melaena Hampson, 1900, J. Bombay N. H. Soc., **13**, p. 50.

Amata flavolavata Rothschild, 1910, Novit. Zool., **17**, p. 434; 1912, *ibid.*, **19**, p. 375, pl. 3, fig. 24; Hampson, 1915, Cat. Lep. Phal., Suppl., **1** (1914), p. 33; Fletcher, 1925, Cat. Ind. Ins., **8**, p. 14. — ORIGINAL DESCRIPTION: "♀. Nearest *A. melaena* Wlk., but distinguishable at once by the last abdominal segment being orange, and not blue-black as in *melaena* and *melaena andersoni*. Frons orange; tegulae and patagia orange; thorax black, orange at hind edge; antennae entirely black; abdomen bright orange with five black rings. Forewing hyaline orange-yellow, costal area between costal and subcostal nervures with basal three-fifths orange-yellow, area between vein 1 and inner margin orange, a black patch on discocellulars, apex and outer margin narrowly black, nervures black, veins 4 and 5 stalked. Hindwing hyaline orange-yellow, outer margin and nervures black. Length of forewing: 27 mm." (Rothschild, 1910). NEW SYNONYM.

Syntomis flavolavata Zerny, 1912, Wagner's Lep. Cat., **7**, p. 21; Seitz, 1913, Gross-Schm. Erde, **10**, p. 73.

Black wing markings reduced. The costal hindwing margin yellowish. Abdominal bands wide and not interrupted at the middle.

Types. S. andersoni: Holotype, female, Yunnan (B.M.); *A. flavolavata:* monotype, female, Khasia Hills, Assam (B.M.)

Remarks. There is no doubt that *diaphana* and *baiaea* are conspecific. The author had at his disposal both these forms and could not find any constant features which would distinguish one form from the other. The specimens like *horishana* and *hoppo* were found among the populations of ssp. *diaphana* from the continental part of China, and Kawada (1934, *loc. cit.*) was right in considering both Formosan "species" as forms of *diaphana* which he erroneously called *muirheadi*. The ab. *melas* was found in almost all parts of the ssp. *diaphana* range; similar female specimens with the yellow abdominal markings replaced by

white, the author studied from Ningyuenfu, Morendro Doonai and Chiengmai, also from Java. In the literature *melas* was mentioned also from Himalaya, Nepal (type), Sikkhim, Burma, and Indochina. This form like ab. *andersoni* has no geographical adaptation. A separation of *flavolavata* from this latter form was unreasonable: Rothschild (1910) was wrong in describing the last abdominal segment of *andersoni* female as blue black. The remaining characters of *flavolavata* and *andersoni*, the yellow tinge of the hyaline wing membrane included, are common and may be observed in any population of ssp. *diaphana*.

11b. Caeneressa diaphana muirheadii (Fldr.), new status
Pl. 3, figs. 5-9

Syntomis muirheadii Felder, 1862, Wien. Ent. Mschr., **6**, p. 37; Leech, 1889, Trans. Ent. Soc. London, p. 123. — ORIGINAL DESCRIPTION: "Alis anticis nigricantibus, maculis tribus vittaeformibus aliisque quatuor pone discum hyalinis, posticis, margine costali et externo exceptis, hyalinis, fronte scapulisque luteis, cingulis abdominalibus ochraceis. ♂ ♀." "Regiones montanas circa Ning-po incolit ista, *S. diaphanae* Kollar affinis. Mas maculas hyalinas exteriores alarum anticarum aliter habet ordinatas quam femina. In eo macula prima inter venam subcostalem et discoidalem seperiorem jaceat, in femina inter ramos ultimos subcostales. Macula supra rami mediani primi basin minuta est, in femina autem vittaeformis." (Felder, 1862).

Zygaena muirheadii Kirby, 1892, Synon. Cat. Lep. Het., **1**, p. 95.

Syntomis muirheadi Hampson, 1898, Cat. Lep. Phal., **1**, p. 95; Leech, 1898. Trans. Ent. Soc. London, p. 322; Seitz, 1909, Gross-Schm. Erde, **2**, p. 40, pl. 9g [fig. 3]; Zerny, 1912, Wagner's Lep. Cat., **7**, p. 24; Seitz., 1913, *op. cit.*, **10**, p. 70; Draeseke, 1926, Iris, **40**, p. 46; Wileman, 1929, Trans. Ent. Soc. London, **76**, p. 421, 429-431, pl. 20, fig. 11; Wu, 1938, Cat. Ins. Sinens., **4**, p. 630.

Syntomis muirheadi (ssp. or ab.) *aucta* (non Leech) Hampson, 1898, Cat. Lep. Phal., **1**, p. 95; Seitz, 1909, Gross-Schm. Erde, **2**, p. 40; 1913, *op. cit.*, **10**, p. 70; Wu, 1938, Cat. Ins. Sinens., **4**, p. 630.

Amata muirheadi Fletcher, 1925, Cat. Ind. Ins., **8**, p. 17.

Wings with black markings more distributed and hyaline areas forming spots on the black ground. The spot edges, the forewing subcostal area, and the middle cell of the hindwing, often with a taint of yellow scales. Orange-yellow abdominal bands mostly interrupted or considerably narrowed dorsally. Thorax usually with orange-yellow longitudinal streaks well developed.

Types. Allotype, female, Ningpo, Province Chekiang (Tring Museum; cf. Wileman, 1929); holotype, male, is apparently missing.

Additional material examined. Three males and three females, Suifu, Province Szechwan, April 8, 1922, November, D. C. Graham (U.S.N.M.); four males, Shinkaisi, Omeishan, Province Szechwan, 4400 ft. alt., August, D. C. Graham (U.S.N.M.); one female, Chengfu, Province Szechwan, June, D. C. Graham (U.S.N.M.); one female, Chungking, Province Szechwan, September, 1941 (M.K.); one female, Tungjen, Province Kweichow, September 8, 1928, C. B. Wahl (A.M.N.H.); one male, Nangking, Province Kiangsu, June 15, 1933, H. Höne (M.K.); one male, Lungtan near Nangking, Province Kiangsu, June 3, 1933, H. Höne (M.K.); one male, East Tienmushan, Province Chekiang, 1500 m. alt., June 13, 1931, H. Höne (M.K.); one male and one female, the same locality, May 25, 1931, H. Höne (Z.C.M.); three males and one female, West Tienmushan, Province Chekiang, 1600 m. alt., May 29, September 2-3, 1932, H. Höne (M.K.); one male, Mokanshan, Province Chekiang, May 31, 1931, H. Höne (M.K.); four females, Yenping, Province Fukien, June 28, August 8, and September 9, 1917 (A.M.N.H.); one female, Foochow, Province Fukien (U.S.N.M.); one male and two females, Shaowu, Province Fukien, 500 m. alt., May 9 till 24, August, 1937, J. Klapperich (M.K.); one male, the same locality (genitalia preparation no. S.036; Z.C.M.); one male and three females, Kwangtseh, Province Fukien, August 28 till September 7, 1937, J. Klapperich (M.K.); one male, the same locality (Z.C.M.).

Range. Chinese provinces Szechwan, Kweichow, Kiangsu, Chekiang, and Fukien.

Variation. This subspecies varies chiefly in size. The wing pattern is more or less constant; only the varied shape and size of the forewing extra spot above the vein Cu_2 affects the width of the black wing border. The yellow abdominal girdles are mostly well developed; only in one female from Chungking is there no girdle on the second tergite.

Remarks. Hampson (1898) and some other authors ranked *Syntomis aucta* Leech (The Entom., **31**, 1898, p. 153) to *muirheadii*, but by mistake. The present author had an opportunity to study the male genitalia of the type of *aucta* on the basis of a photograph received from the British Museum. This examina-

tion showed that *aucta* was an independent species belonging to the genus *Amata* F.

11c. Caeneressa diaphana hunanensis, new subspecies

Pl. 3, figs. 10, 11

From the preceding subspecies this differs by a slight development of the yellow pigmentation of the patagia and thorax. Patagia black with some yellowish scales at the anterior edge; longitudinal yellow streaks of the thorax obsolescent.

Types. Holotype, male (May 30), allotype, female (June 6), and two paratypes (M.K.); two further paratypes, one male and one female (Z.C.M.). The series originates from Hoengshan, Province Hunan, 900 m. alt., May 28 till June 6, September 4, 1933, H. Höne.

Range. Known from the above locality only.

Remarks. Although the distinction between the new subspecies and ssp. *muirheadii* seems minimal, it is constant in all the specimens examined from Hoengshan. On the other hand, not any specimen of *muirheadii,* of the large series examined, has the yellow of the patagia so much reduced as in *hunanensis.* This fact gives the ground for considering the Hunan specimens a separate geographical form.

12. Caeneressa graduata (Hmps.), new combination

Pl. 4, figs. 16, 17

Syntomis graduata Hampson, 1898, Cat. Lep. Phal., **1**, p. 67, pl. 2, fig. 28; Seitz, 1909, Gross-Schm. Erde, **2**, p. 40, pl. 9f [fig. 4]; Zerny, 1912, Wagner's Lep. Cat., **7**, p. 22; Wu, 1938, Cat. Ins. Sinens., **4**, p. 629. — ORIGINAL DESCRIPTION: "♂. Head, thorax, and abdomen black; tegulae and a patch on metathorax crimson; abdomen with subdorsal and lateral crimson streaks, the subdorsal streaks conjoined by segmental lines. Fore wing with hyaline streak above vein 1 from near base to near termen, and a series of spots between veins 2 and 5 and 6 and 8, diminishing in size towards costa. Hind wing with hyaline patches below the cell and above vein 2, and spot between veins 3 and 5, which are stalked." "♀ with broad dorsal crimson fascia on abdomen." (Hampson, 1898).

Male. Antennae biserrate, black, short white tipped. Head

black. Patagia red; tegulae black. Thorax black with a posterior red patch; pectus with two red patches on each side. Legs brownish, slightly paler than the body. Abdomen blackish brown; postsegmental, crimson bands on first to seventh tergites (incl.); a crimson mediodorsal and two lateral, longitudinal lines; sternites entirely black. Length of the forewing: 14-15 mm.

Wings black brownish, rather diffusely scaled, with hyaline spots. Forewing with a three-fourths long, slightly arcuate spot (m_{1+3}) below the middle cell; a short, wedge-shaped, sometimes diffusely blackish scaled spot (m_2) in the middle cell; an exterior series of spots consisting of more or less short rectangular spot (m_4) between the veins M_1 and R_5 accompanied by an extra spot above and a little, inconstant extra spot below; two inward pointed spots (m_5 and m_6) between the veins M_2 and Cu_1, and an extra spot between the veins Cu_1 and Cu_2 bordering on the lower edge of the middle cell; these exterior spots are separated from each other by veins only. Hindwing black bordered, with an elongate hyaline area below the middle cell.

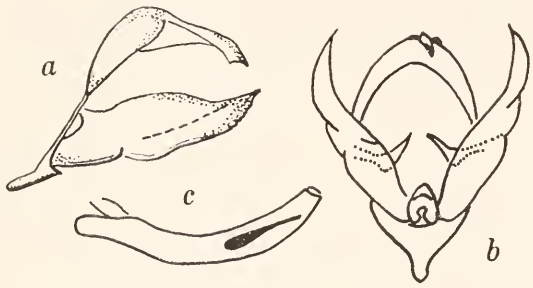

Fig. 9. Male genitalia of *Caeneressa graduata* (Hmps.); preparation no. S.064 (M.K.).
a, lateral view; *b*, ventral view; *c*, aedoeagus.

Female. Similar to the male. Antennae simple. Abdomen with a broad, dorsal, longitudinal, crimson fascia.

Male Genitalia (Fig. 9). Tegumen rather narrow; uncus moderately long, dilated and pointed distally; saccus broad, rather short, with a narrow tip. Valvae symmetrical; sacculus short;

costa slightly arched between the upper and distal edges; tip of the valva acute, directed slightly upward; processus basales extending only to the vallum penis. Fultura inferior ovate. Aedoeagus moderately sized, curved upward; one single, long cornutus, thickened at the base, very narrowed distally.

Type. Holotype, male, Kiangnan (B.M.).

Additional material examined. One male, Lungtan near Nangking, Province Kiangsu, May 8, 1933, H. Höne (genitalia preparation no. S.064; M.K.).

Range. Chinese province Kiangsu.

Remarks. In the abdominal pattern, this species is similar to *C. tienmushana,* n. sp., but it has crimson bands instead of the yellow ones in the latter species, and otherwise shaped genitalia. From all other *Caeneressa* species, *graduata* differs in its peculiar venation having the hindwing veins M_2 and Cu_1 stalked.

13. Caeneressa tienmushana, new species

Pl. 4, fig. 5

Male. Antennae slightly serrate, black, short yellowish tipped. Head black; frons and palpi yellow. Patagia yellow, at the middle blackish; tegulae entirely yellow. Thorax blackish brown; pectus with two yellow patches on each side. Legs brownish, diffusely yellowish scaled, especially on the tarsi; interior side of the coxae yellow. Abdomen brownish black; first to seventh tergites (incl.) with narrow, postsegmental, yellow bands; a yellow mediodorsal and two longitudinal, lateral lines; the corresponding sternites in their greatest part yellow; tip brownish black with sparse, postsegmental, yellow hairs. Length of the forewing: 14 mm.

Wings hyaline with brownish black veins and borders dilated at the apex. Forewing moreover with a broad, brownish black, discal spot and a black ray along the vein M_2 connecting this spot with the wing borders; a border tooth along the vein Cu_2; all the hyaline areas more or less spot-shaped; subcostal area yellow. Hindwing narrower, brownish black bordered; dorsum yellow scaled; middle cell and costa brownish black, the latter slightly tinged with yellow. The reverse of both wings with a diffuse, yellow scaling along the costa and dorsum.

Male Genitalia (Fig. 10). Tegumen narrow, moderately curved, dilated distally and with an acute tip; saccus moderately long, almost straight. Valvae leaf-shaped, the left valva considerably shorter; tip pointed; sacculus rather narrow, slightly thickened, with an obtuse tip; processus basales short, slightly curved at the tips, extending only to the vallum penis. Fultura inferior elongate-ovate. Aedoeagus rather long, slender,

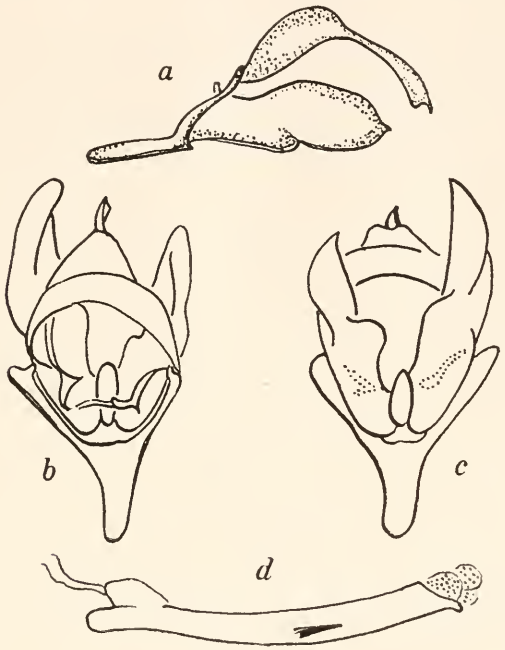

Fig. 10. Male genitalia of *Caeneressa tienmushana*, new species; preparation no. S.051 (M.K.).
a, lateral view; *b*, dorsal view; *c*, ventral view; *d*, aedoeagus.

slightly curved upward; a single, thorn-like cornutus, and a fine, distal cuneus of numerous, little, chitinous cones.

Type. Monotype, male, West Tienmushan, Province Chekiang, June 9, 1935, H. Höne (genitalia preparation no. S.051; M.K.).

Range. Known from the above locality only.

Remarks. Allied to *rubrozonata* Pouj., especially to its ab. *leucoma* Leech, from which the new species differs in its antennae, head color, tegulae, legs, and abdomen, in more enlarged hyaline wing areas, and in genitalia. The wing pattern is somewhat similar to that of *obsoleta* Leech but the forewing spots are less far apart.

14. Caeneressa rubrozonata (Pouj.), new combination

The synonymy is given under subspecies.

Male. Antennae slightly serrate or simple, black, short white tipped. Head black; frons white. Patagia black, sometimes shot with reddish or yellowish, especially at sides, seldom entirely red or yellow; tegulae red or yellow with black hair-tufts on the

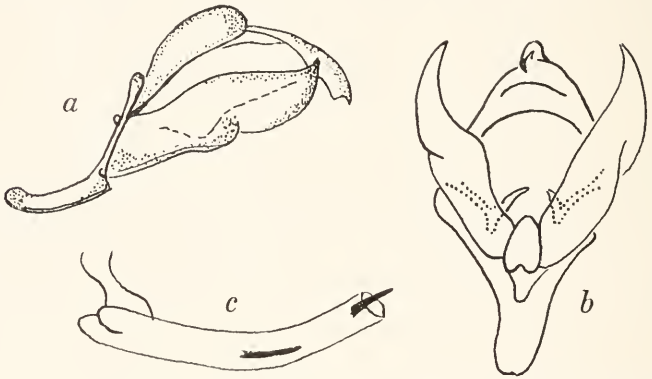

Fig. 11. Male genitalia of *Caeneressa rubrozonata* (Pouj.); preparation no. S.052 (Z.C.M.).
a, lateral view; *b*, ventral view; *c*, aedoeagus.

tips, or black with colored shoulders. Thorax black; pectus unicolorous, or with a pale reddish or yellowish patch on each side. Legs black; the interior side of the coxae white, sometimes also the femora and tibiae white or whitish streaked. Abdomen black; first tergite and the further six segments with postsegmental, red or yellow girdles; they are more or less broad, complete or interrupted ventrally, jointed between themselves laterally; those on the second and third tergites often narrower or absent, that on the seventh tergite also absent sometimes. Wings black

with white, hyaline spots. Length of the forewing: 11-16 mm.

Forewing with five ground spots: an elongate-cuneiform spot (m_2) in the middle cell, usually as broad as this latter; a long spot (m_{1+3}) below it, reaching from the wing base almost to the tornus, or the basal part of this spot (m_1) absent; a spot (m_4) in the area between the veins R_5 and M_1 mostly shorter than that (m_6) between the veins M_3 and Cu_1; a spot (m_5) between the veins M_2 and M_3 often the smallest in the exterior spots series; sometimes more or less developed extra spots above the vein Cu_2 and at both sides of the spot m_4. Hindwing with a more or less large spot placed right at the dorsum and separated from it by a narrow black border; occasionally this spot reaches across the vein Cu_1.

Female. Similar to the male. Antennae simple. Frons reddish, yellowish, grey or black. Legs entirely black. Girdle on the seventh tergite always absent.

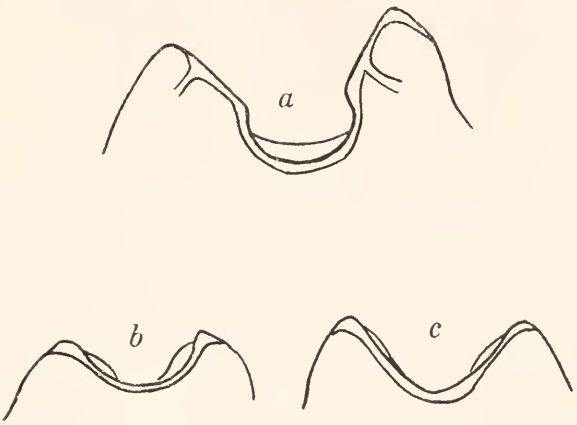

Fig. 12. Postsegmental edge of the seventh abdominal sternite of two *Caeneressa* species; *a*, *C. ningyuena*, new species; *b*, *c*, *C. rubrozonata* (Pouj.).

Male Genitalia (Fig. 11). Like those in *graduata* Hmps., with symmetrical valvae. Aedoeagus equally broad, slightly curved upward, with a small coecum penis; two elongate, sharp cornuti.

Female Genitalia (Fig. 12). The postsegmental edge of the seventh abdominal sternite more or less concave.

Range. Chinese provinces Szechwan, Chekiang, and Fukien.

Variation. Individual variation of the wing and abdomen markings, and of the body color and head scaling. Two geographical subspecies.

Remarks. Hampson (1898) wrote on this species: "both wings with veins 4 and 5 shortly stalked." As a matter of fact, this character is inconstant, and the two veins mentioned are often only coincident.

14a. Caeneressa rubrozonata rubrozonata (Pouj.), new status

Pl. 4, figs. 6-9

Syntomis rubrozonata Poujade, 1886, Bull. Soc. Ent. France, ser. 6, **6**, p. CXVII; Leech, 1898, Trans. Ent. Soc. London, p. 324; Hampson, 1898, Cat. Lep. Phal., **1**, p. 85; Seitz, 1909, Gross-Schm. Erde, **2**, p. 40; Zerny, 1912, Wagner's Lep. Cat., **7**, p. 25; Draeseke, 1926, Iris., **40**, p. 46. — ORIGINAL DESCRIPTION: "Envergure: ♂, 30 mill.; ♀, 32 mill. Ailes hyalines, avec les taches, les nervures et les bords noirs. Les supérieures sont très allongées et assez pointues; la bordure externe s'élargit à l'apex environ du quart de l'aile, où elle est reliée par une bande étroite à une tache presque carrée qui limite la cellule et touche au bord costal; cette bordure s'élargit encore en une tache presque carrée, plus large que la précédente, entre les deux derniers rameaux de la nervure médiane. Ailes inférieures très petites, lancéolées, n'égalant pas en longueur la moitié des supérieures, ayant l'apex jusqu'au tiers de l'aile environ et le bord costal noirs. Tête, thorax et abdomen noirs, se dernier ayant les arceaux supérieures bordés de rouge vermillon; antennes noires, blanches à l'extrémité. Le mâle seul a le front blanc ainsi que la poitrine, le devant des hanches et des lignes sur les cuisses." (Poujade, 1886).

Zygaena rubrizonata Kirby, 1892, Synon. Cat. Lep. Het., **1**, p. 93.

The black of the wings considerably reduced; the hyaline spots of the forewing exterior spots series placed near the middle cell. In the male the abdomen not girdled ventrally.

Types. Mupin, Province Szechwan (probably in the Musée d'Histoire Naturelle, Paris).

Additional material examined. Four males and one female, West of Yachow, June, 2000 to 7000 ft. alt., D. C. Graham (U.S.N.M.); one male, Shinkaishi, Omeishan, Province Szechwan, 4400 ft. alt., July, D. C. Graham (U.S.N.M.).

Range. Chinese province Szechwan.

Variation. The nominotypical form has red body markings. That with yellow markings was described as an aberration.

ab. LEUCOMA Leech (Plate 4, figs. 6, 8, 9)

Syntomis consequa Leech, 1898, The Entom., **31**, p. 153; 1898, Trans. Ent. Soc. London, p. 324; Hampson, 1898, Cat. Lep. Phal., **1**, p. 96, pl. 5, fig. 2; Seitz, 1909, Gross-Schm. Erde, **2**, p. 40, pl. 9e [fig. 1]; Zerny, 1912, Wagner's Lep. Cat., **7**, p. 20. — ORIGINAL DESCRIPTION: "Female. Wings almost exactly identical with those of *S. rubrozonata*, but the frons is greyish, the collar is yellow, and there are six yellow bands on abdomen, the first of which is broad. Expanse, 28 millim." (Leech, 1898). NEW SYNONYM.

Syntomis leucoma Leech, 1898, The Entom., **31**, p. 154; 1898, Trans. Ent. Soc., London, p. 324. — ORIGINAL DESCRIPTION: "Frons, tegulae, and fore tibiae white; thorax and abdomen black, the latter with seven yellow bands, the last two of which are almost confluent. Primaries hyaline, venation black; there is a black spot at outer extremity of cell, and this is united by a bar with the broad apical portion of the black outer marginal border; the latter is toothed at veins 2 and 3; there is a curved black streak along inner margin. Secondaries hyaline, with black outer border which is broadest at apex. Expanse, 28 millim." (Leech, 1898).

Syntomis rubrozonata (part.) Hampson, 1898, Cat. Lep. Phal., **1**, pl. 3, fig. 7; Seitz, 1909, Gross-Schm. Erde, **2**, pl. 9f [fig. 5].

Syntomis rubrozonata ab. *leucoma* Hampson, 1898, Cat. Lep. Phal., **1**, p. 85; Seitz, 1909, Gross-Schm. Erde, **2**, p. 40; Zerny, 1912, Wagner's Lep. Cat., **7**, p. 25.

With yellow body markings instead of red ones.

Types. Syntomis leucoma: Monotype, male, Omeishan, Province Szechwan, 3620 ft. alt., May and June, 1890 (B.M.); *S. consequa:* monotype, female, Mupin, Province Szechwan, June, Kricheldorff (B.M.).

Remarks. There is no doubt that *leucoma* and *consequa* are different sexes of the same form although *consequa* has been erroneously considered by most authors as an independent species. I retain for this aberration of *rubrozonata* the first of the two simultaneously-established names because it has already been used in this sense. This aberration is known to me in one male specimen from the above-mentioned series from Yachow.

14b. Caeneressa rubrozonata eurymelaena, new subspecies
Pl. 4, figs. 10-15

The black of the wings distributed; the exterior series of the hyaline forewing spots remote from the middle cell. The abdomen of the male usually girdled also ventrally.

Types. Holotype, male, allotype, female, eight males and seven females, paratypes, Kuatun, Province Fukien, 2300 m. alt., May 11 till June 6, July 23 till August 8, 1938, J. Klapperich (M.K.); further paratypes, two males and one female, the same locality (Z.C.M.).

Additional material examined. One male and two females, Mokanshan near Hangchow, Province Chekiang, June 9 till 16, August 7 till 19, 1930, H. Höne (M.K.); one male and two females, the same locality (male genitalia preparation no. S.053; Z.C.M.); one male, West Tienmushan, Province Chekiang, 1600 m. alt., June 28, 1932, H. Höne (genitalia preparation no. S.052; Z.C.M.); one male and one female, East Tienmushan, Province Chekiang, 1500 m. alt., June 7 till 20, 1931, H. Höne (M.K.).

Range. Chinese provinces Chekiang and Fukien.

Variation. As in the preceding subspecies, ab. *leucoma* is known here also (one male from West Tienmushan and one male and one female from East Tienmushan). In six female specimens (one from Mokanshan and five from Kuatun) the patagia are entirely red. Sometimes there are no girdles on the ventral surface (two females from Mokanshan, three males and nine females from Kuatun). Most of the specimens have extra spots in the forewings; they are absent in only four specimens (one male and three females from Mokanshan).

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zernyi, new species, 399, 400, 411, 412, **415**
Zygaena (part.) Kirby, 392

[1] Synonyms are italicized. Figures in bold-face refer to pages on which the basic discussion is given.

Plate 1

Fig. 1. *Caeneressa proxima*, new species, holotype, male, Lienping, Province Kwangtung, May, 1922, H. Höne (M.K.).

Fig. 2. *Idem*, paratype, male, the same data.

Fig. 3. *Idem*, allotype, female, Hoengshan, Province Hunan, 900 m. alt., May 29, 1933, H. Höne (M.K.).

Fig. 4. *C. pratti* (Leech), holotype, male, Kiukiang, Province Kiangsi, June, 1887, A. E. Pratt (B.M.).

Fig. 5. *Idem*, allotype, female, the same data (B.M.).

Fig. 6. *Idem*, male genitalia of the holotype (B.M.).

Fig. 7. *C. klapperichi*, new species, holotype, male, Kuatun, Province Fukien, 2300 m. alt., June 16, 1938, J. Klapperich (M.K.).

Fig. 8. *Idem*, allotype, female, the same locality, June 20, 1938, J. Klapperich (M.K.).

Fig. 9. *C. hoenei*, new species, holotype, male, Tapaishan in Tsinling, Province Shensi, 1700 m. alt., July 7, 1936, H. Höne (M.K.).

Fig. 10. *Idem*, allotype, female, the same data (M.K.).

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PLATE 1

Plate 2

Fig. 1. *Caeneressa actea* (Swinh.), holotype, male, Khasia Hills, Assam, Hamilton (B.M.).

Fig. 2. *Idem*, allotype, female, the same data (B.M.).

Fig. 3. *Idem*, male genitalia of the holotype (B.M.).

Fig. 4. *C. swinhoei* (Leech), holotype, male, Mupin, Province Szechwan, June, Kricheldorff (B.M.).

Fig. 5. *Idem*, allotype, female, Chiatingfu, Province Szechwan, July, A. E. Pratt (B.M.).

Fig. 6. *Idem*, male genitalia of the holotype (B.M.).

Fig. 7. *C. obsoleta* (Leech), holotype, female, Ningpo, Province Chekiang, July, 1886 (B.M.).

Fig. 8. *Idem*, female, Kuatun, Province Fukien, May 26, 1938, J. Klapperich (M.K.).

Fig. 9. *Idem*, female, the same locality, June 11, 1938, J. Klapperich (M.K.).

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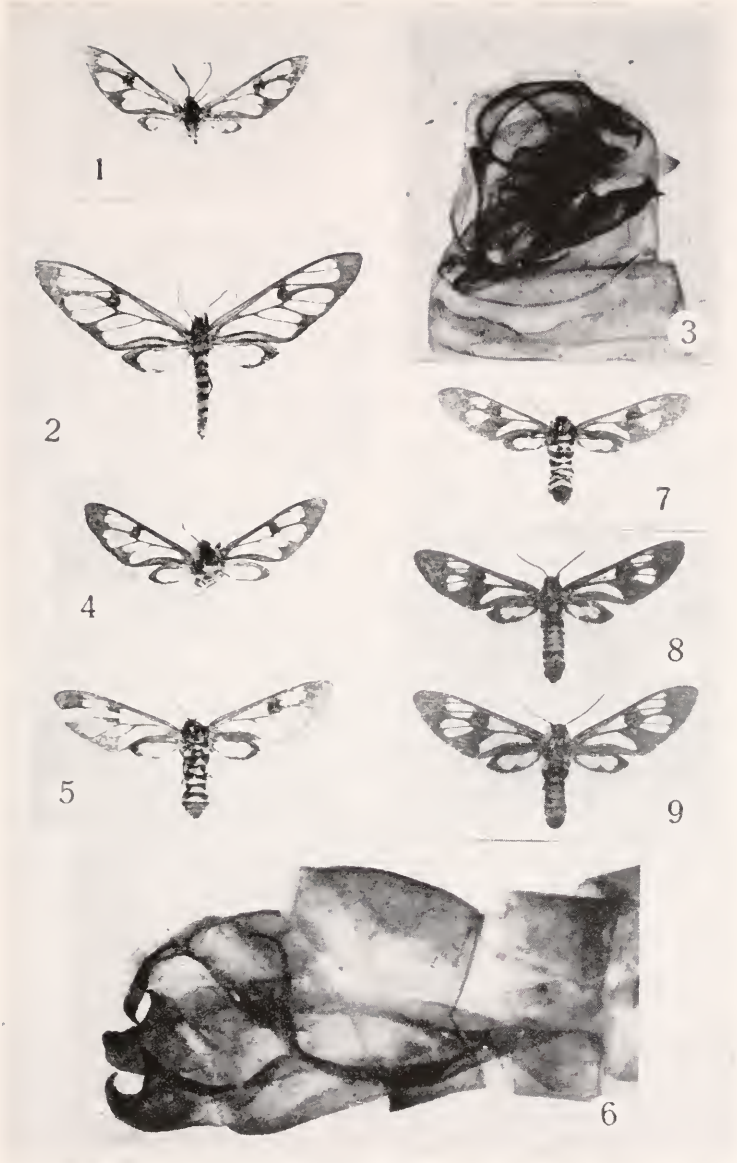

PLATE 2

Plate 3

Fig. 1. *Cacneressa diaphana diaphana* (Koll.), male, Ningyuenfu, Province Szechwan (Z.C.M.).

Fig. 2. *Idem*, female, Tjibodas, Java, 1400-1800 m. alt., November 1-20, 1927, H. Burgeff (Z.C.M.).

Fig. 3. *Idem*, ab. *andersoni* Moore, holotype, female, Province Yunnan (B.M.).

Fig. 4. *Idem*, ab. *melas* Wkr., holotype, female, Nepal, India (B.M.).

Fig. 5. *C. diaphana muirheadii* (Fldr.), male, East Tienmushan, Province Chekiang, May 25, 1931, H. Höne (M.K.).

Fig. 6. *Idem*, male, Nangking, Province Kiangsu, June 15, 1933, H. Höne (M.K.).

Fig. 7. *Idem*, male, West Tienmushan, Province Chekiang, September 2, 1932, H. Höne (M.K.).

Fig. 8. *Idem*, male, the same data (M.K.).

Fig. 9. *Idem*, female, East Tienmushan, Province Chekiang, May 25, 1931, H. Höne (Z.C.M.).

Fig. 10. *C. diaphana hunanensis*, new subspecies, holotype, male, Hoengsham, Province Hunan, 900 m. alt., May 30, 1933, H. Höne (M.K.).

Fig. 11. *Idem*, allotype, female, the same locality, June 1, 1933 (M.K.).

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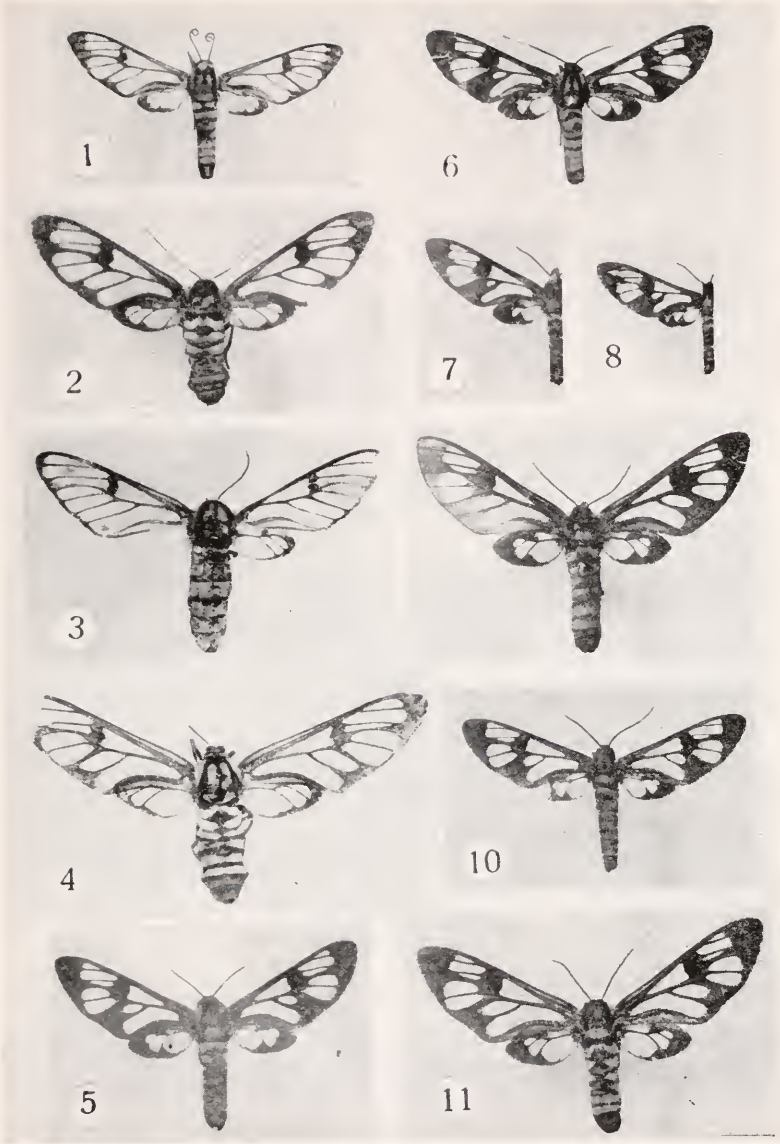

PLATE 3

Plate 4

Fig. 1. *Cacoecessa dispar*, new species, holotype, male, Kuatun, Province Fukien, 2300 m. alt., May 19, 1938, J. Klapperich (M.K.).

Fig. 2. *Idem*, allotype, female, the same locality, May 6, 1938, J. Klapperich (M. K.).

Fig. 3. *C. zerny*i, new species, monotype, male, Shinchow near Canton, Province Kwangtung (Z.C.M.).

Fig. 4. *ningyuena*, new species, monotype, female, mountains near Ningyuenfu, Province Szechwan (Z.C.M.).

Fig. 5. *C. tienmushana*, new species, monotype, male, West Tienmushan, Province Chekiang, June 9, 1935, H. Höne (M.K.).

Fig. 6. *C. rubrozonata rubrozonata* (Pouj.) ab. *leucoma* Leech, male, west of Yachow, June, 2000 to 7000 ft. alt., D. C. Graham (U.S.N.M.).

Fig. 7. *C. rubrozonata rubrozonata* (Pouj.), female, the same data (U.S.N.M.).

Fig. 8. *C. rubrozonata rubrozonta* (Pouj.) ab. *leucoma* Leech, monotype of *Syntomis leucoma* Leech, male, Omeishan, Province Szechwan, 3620 ft. alt., May and June, 1890 (B.M.).

Fig. 9. *Idem*, monotype of *Syntomis consequa* Leech, female, Mupin, Province Szechwan, June, Kricheldorff (B.M.).

Fig. 10. *C. rubrozonata curymelaena*, new subspecies, ab. *leucoma* Leech, male, West Tienmushan, Province Chekiang, 1600 m. alt., June 28, 1932, H. Höne (M.K.).

Fig. 11. *C. rubrozonata curymelaena*, new subspecies, holotype, male, Kuatun, Province Fukien, 2300 m. alt., May 19, 1938, J. Klapperich (M.K.).

Fig. 12. *Idem*, allotype, female, the same locality, May 23, 1938, J. Klapperich (M.K.).

Fig. 13. *Idem*, paratype, female, the same locality, June 3, 1938, J. Klapperich (M.K.).

Fig. 14. *Idem*, female, Mokanshan, Province Chekiang, August 19, 1930, H. Höne (M.K.).

Fig. 15. *Idem*, ab. *leucoma* Leech, female, East Tienmushan, 1500 m. alt., June 26, 1931, H. Höne (M.K.).

Fig. 16. *C. graduata* (Hmps.), holotype, male, Kiangnan, Province Kiangsu (B.M.).

Fig. 17. *Idem*, male, Lungtan, Province Kiangsu, May 8, 1933, H. Höne (M.K.).

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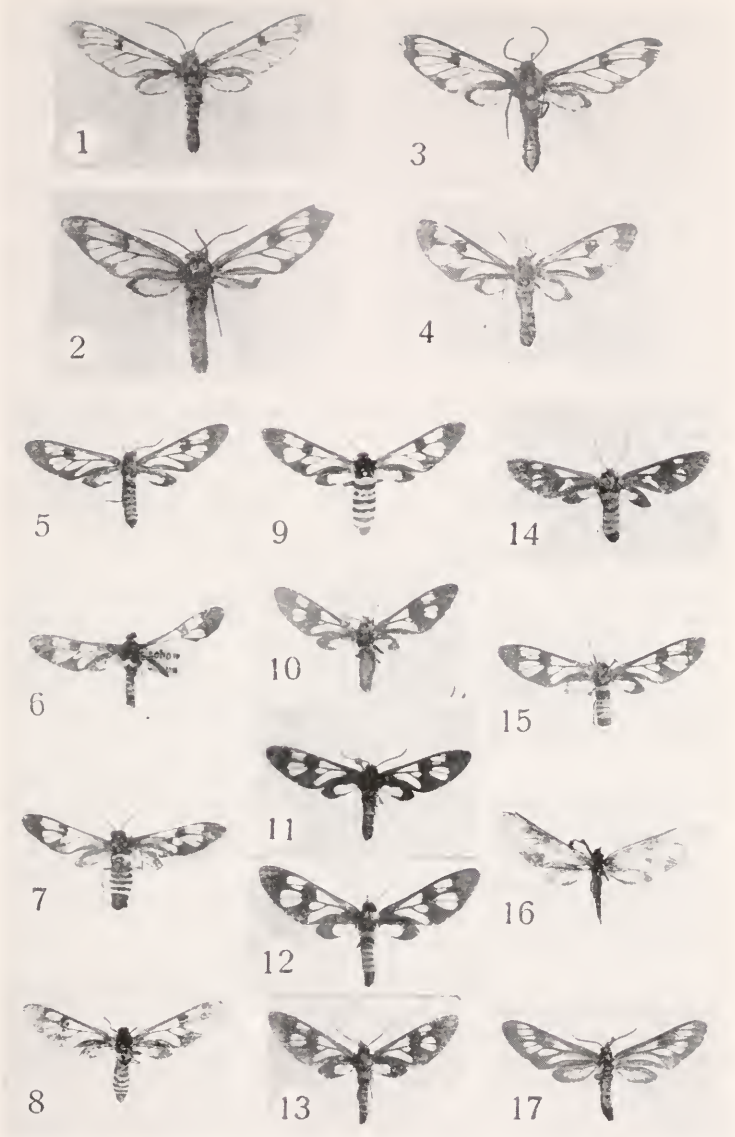

PLATE 4

Bulletin of the Museum of Comparative Zoology
AT HARVARD COLLEGE
Vol. 116, No. 8

A COMPARATIVE MORPHOLOGICAL STUDY OF THE PROVENTRICULUS OF ANTS (HYMENOPTERA: FORMICIDAE)

By Thomas Eisner
Biological Laboratories, Harvard University, Cambridge, Mass.

With Twenty-five Plates

CAMBRIDGE, MASS., U. S. A.
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MUSEUM OF COMPARATIVE ZOOLOGY
AT HARVARD COLLEGE

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Johnsonia (quarto) 1941 — A publication of the Department of Mollusks. Vol. 3, no. 35 is current.

Occasional Papers of the Department of Mollusks (octavo) 1945 — Vol. 2, no. 21 is current.

Proceedings of the New England Zoölogical Club (octavo) 1899–1948 — Published in connection with the Museum. Publication terminated with Vol. 24.

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July, 1957

No. 8 — *A Comparative Morphological Study of the Proventriculus of Ants (Hymenoptera: Formicidae)*

By Thomas Eisner[1]

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[1] This study was supported largely by the *Lalor Foundation*, and in part by a grant from the *U. S. Public Health Service*. It was published by a grant from the *Wetmore Colles Fund*, and a grant-in-aid from the *Sigma-Xi-RESA Research Fund*.

(fig. 84); *Oecophylla* (fig. 83); *Gigantiops* (p. 474); *Dendromyrmex* (p. 474); *Opisthopsis* (p. 474); *Polyergus* (p. 474); *Polyrachis* (p. 474); *Pseudolasius* (p. 474).
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INTRODUCTION

Adult Hymenoptera are distinctly discontinuous in their feeding habits, and subsist very largely on fluids (Bischoff '27). The relatively large amount of liquid nutrient gathered during one of the intensive feeding periods is not passed directly into the midgut (text fig. 1, *m. g.*), but is first temporarily retained within a sac-like dilation of the stomodaeum called the crop (text fig. 1, *cr.*). At intervals, controlled amounts of liquid are released from the crop to the midgut. Since in this way food is passed gradually into the midgut, thereby avoiding a sudden dilution of midgut enzymes at feeding, the digestive and absorptive processes within the midgut proceed at optimal efficiency. The organ that regulates the delivery of fluid from crop to midgut is the proventriculus (text fig. 1, *pv.*). In adult Hymenoptera the proventriculus, as usually developed, is no mere strait between crop and midgut. It consists of a relatively voluminous, strongly-muscled, bulb (text figs. 2, 3), opening anteriorly to the crop through a cruciform portal, and posteriorly into the midgut through a slender, tubular, stomodaeal valve.

From the structure of the organ it is clear that this type of proventriculus represents a distinct adaptation to the fluid nature of the diet. It is, in fact, nothing but a pump, with intake and exhaust valves provided respectively by the portal and the stomodaeal valve. Proventricular activity consists of rhythmic contractions and expansions of the bulb by means of which a regulated pumping is accomplished (Bailey '52, Schreiner '52). Small particulate matter, such as pollen grains, present no obstacle to proventricular pumping. We know, for instance, that in *Prosopis, Vespa,* and *Bombus,* even relatively dense suspensions of pollen grains are effectively transferred to the midgut without proventricular obstruction (Bailey '54). In *Apis,* the proventriculus may even, under special circumstances, convey pollen grains to the midgut independently from their liquid medium (Bailey '52, Schreiner '52); but this filtering ability

is probably secondary to the primary fluid-pumping function of the organ (Bailey '54).

Among the hymenopterous insects thus far investigated, the proventriculus is monotonously uniform in structure from family to family. This circumstance throws into striking relief the exceptional group: the ants. Within this single medium-sized family, the proventriculus shows a greater diversity of structural types than can be found in any other insect family — greater even than in most entire orders.

According to the theory of Wheeler ('23), a fundamental bond of social life among the ants is the exchange of nutrient through regurgitative feeding. In adaptation to regurgitative feeding the crop assumes a new and overwhelmingly important function in the social community. It serves not only as a receptacle for the nutrient reserves of the individual, but also as a communal reservoir, or, as Forel aptly termed it, a "social stomach," from which the non-foraging members of the community may derive their nourishment. Some of the higher ants, in which regurgitative feeding achieves its highest degree of specialization, have even developed special storage castes ("repletes") with enormously distended crops and expansible gasters (e.g. *Leptomyrmex*, *Melophorus*, *Prenolepis*, *Myrmecocystus*, *Proformica*, etc.).

In ants, as in all Hymenoptera, the proventriculus serves primarily as a pump. However, the development of a crop capable of storing nutrient, not only *in amounts far beyond those required by the individual forager*, but also *for prolonged periods of time*, has been accompanied by modifications in the proventriculus allowing that organ to assume the additional function of effectively damming the posterior outlet of the crop. The ant proventriculus is thus seen to serve a dual purpose, being responsible not only to the individual, for whom it regulates the nutrient supply to the midgut, but also to the community, which it serves by acting as a passive dam to the "social stomach." During evolutionary refinement of its emergent social function as

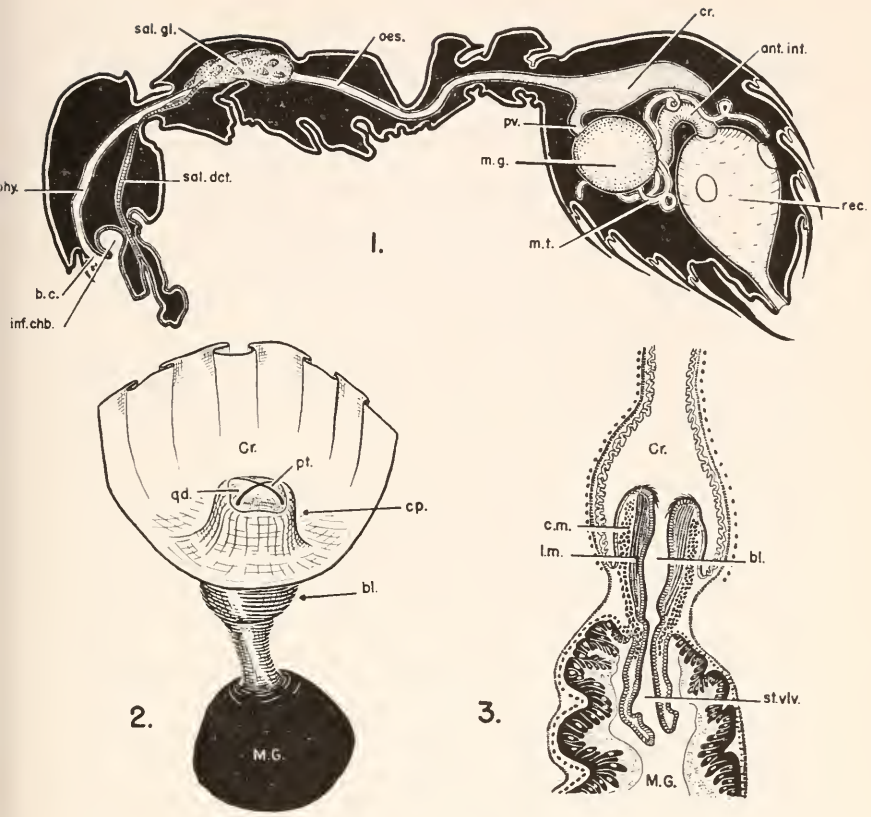

Fig. 1. Digestive tract of the ant *Myrmica rubra* (simplified, with some cephalic structures omitted; after Janet). Abbreviations: *ant. int.*, anterior intestine; *b. c.*, buccal cavity; *cr.*, crop; *inf. chb.*, infrabuccal chamber; *m. g.*, midgut; *m. t.*, malpighian tubule; *oes.*, oesophagus; *phy.*, pharynx; *pv.*, proventriculus; *rec.*, rectum; *sal. dct.*, salivary duct; *sal. gl.*, salivary gland.

Fig. 2. Proventriculus of *Apis* (after Snodgrass, relabelled). Abbreviations: *bl.*, bulb; *cp.*, cupola; *Cr.*, crop; *M. G.*, midgut; *pt.*, portal; *qd.*, quadrant.

Fig. 3. Longitudinal section through proventriculus of *Apis* (after Snodgrass, relabelled). Abbreviations: *c. m.*, circular muscles; *l. m.*, longitudinal muscles; *st. vlr.*, stomodaeal valve; other labels as in Figure 2.

a dam, the ant proventriculus has solved its new mechanical problems by means of a number of different morphological changes, accounting for the extraordinary diversity in structure by which the organ has come to express itself in the ants.

The present study has as its chief objectives the analysis of structure, and the explanation of function, of each of the principal kinds of proventriculi known to occur among the ants. This structural analysis draws from, and is resynthesized with a view to augmenting, the general body of knowledge concerning formicid evolution. All three elements of this approach — anatomical, mechanical, and phylogenetic — *have been inextricably involved in each step of the study.*

The ant proventriculus has been the subject of considerable interest in the past; yet, despite several involved descriptions of its anatomy that have appeared, its exact function and mode of action have never been properly understood. Due to its structural variability, the organ has been used extensively as a taxonomic character in the classification of the Dolichoderinae and Formicinae, and in phylogenetic speculations concerning these and other groups. The first accurate anatomical study of the dolichoderine-formicine proventriculus was that of Forel (1878). Emery (1888) followed up Forel's work in a classic comparative monograph, still the basic reference on this organ. He reviewed most of the dolichoderine and formicine tribes, as well as the aberrant myrmicine tribe Cephalotini. Additional concise descriptions of the proventriculus of the Dolichoderinae and Formicinae were given in 1912 and 1925 in the fascicles of Wytsman's Genera Insectorum dealing with these groups. The most recent work deals only with the aneuretine proventriculus (Wilson, Eisner et al. '56) and with the specialized camponotine type (Eisner and Wilson '52). Wherever necessary, reference is made to these works throughout this paper.

The suprageneric classification of the family Formicidae followed here is that advanced by Brown ('54). The aneuretines are given subfamilial rank in accordance with Wilson, Eisner et al. ('56). On the advice of W. L. Brown, Jr. and E. O. Wilson, I am avoiding the use of tribal designations, classification at this level being artificial and currently under revision.

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PART I

MATERIALS AND METHODS

It is impossible fully to understand any proventriculus without considering the closely interdependent structure and function of the two major organic constituents, the cuticular framework and the muscular envelope. Structural data were obtained principally from two types of microscopical preparations. The first of these consisted of the isolated proventricular framework divested of all attached cellular portions. The second type of

preparation consisted of the simple serial sections of the whole proventriculus. The functional and phylogenetic considerations were derived from a careful comparative study of these preparations and such other incidental data as became available.

The following is a brief outline of the procedure used in the making of the preparations and a brief account of the method of illustration employed, with a consideration of its limitations.

Cuticular framework preparations

This method is outlined here in some detail, since it may be of aid to the systematist who uses the ant proventriculus as a taxonomic character.

In order to remove all cellular constituents from the proventriculus, the whole ant is immersed in hot (*ca.* 90°C) 10% aqueous KOH for ½ to 1 hour, or in the same solution at room temperature for 8 to 15 hours. Specimens from either fluid preservative or dry mounts may be treated in this way.

The whole ant is then transferred through several changes of distilled water to remove the alkali, and finally to 70% alcohol, where the proventriculus is dissected out. To this end, a small window is first cut in the gaster, through which the crop can readily be seen as a thin cuticular sac extending backwards from the petiole; the proventriculus itself appears as a small terminal protuberance on the crop. At no time should the proventriculus be severed from the crop, since the crop provides an ideal holdfast by which the proventriculus may be transferred through the various solutions which follow. Furthermore, the positional relationship and proportions of the two organs are in themselves important things for the observer to note. The crop with the proventriculus is seized with fine forceps, extracted from the gaster and transferred directly into the stain.

Chlorazol black E (1% in 70% alcohol) proved to be the most suitable of the stains used (Pantin '48). One to five minutes suffices for adequate staining; overstained specimens are usually, but not always, readily destained in 70% alcohol.

Other cuticular stains such as eosin, acid fuchsin, fast green and picro-creosote (Kennedy '49) offered no advantages over chlorazol black E. Acid fuchsin occasionally proved useful as a counterstain to chlorazol black; the latter stain has a low affinity

for the cupolar or sepalar region of the proventriculus, while acid fuchsin has a strong affinity for these regions only, and was therefore especially useful where it was otherwise impossible to delimit the exact extent of the portal opening of the proventriculus.

The specimen is then passed through two changes of 100% alcohol for about 3 minutes each, and into cedar oil, where it may be stored indefinitely. If whole mounts are desirable, the cedar oil is rinsed off with xylol, and the specimen mounted under a coverslip in balsam or synthetic resin.

In cases in which valuable dried specimens, such as holotypes or uniques, must be studied, the proventriculus can usually be removed without materially damaging the ant. To isolate the proventriculus from such a sample, the specimen is first relaxed in a suitable fluid, such as Barber's fluid or a mild detergent-water mixture, and then the crop and proventriculus are extracted together through an incision in the membrane between the first and second gastric segments. The location of the incision may, of course, vary with the kind and condition of the ant, but a careful and commonsense approach adapted to the individual specimen will usually yield a good proventriculus. As Forel long ago noted, this operation can be performed so neatly that the re-mounted ant is only the better for its incidental bath. Once isolated, the crop and proventriculus can be treated with cold 10% KOH until free of soft tissues, and then handled like any other proventriculus.

Histological serial sections

Unfortunately, many of the genera available for this study were either dried, or had been stored in alcohol for many years, which rendered them useless for histological study. There was also available, however, an adequate series of representative genera properly preserved by histological fixatives (Schaudinn's, Bouin's, Carnoy's). Some of the material that had been preserved in alcohol for relatively short periods of time (about 5 years or less) yielded adequate and, in fact, often remarkably good histological preparations.

Serial sections were made by routine histological technique. The proventriculi were embedded in *Tissuemat* (½ hour), sec-

tioned at 5 to 10 micra, and stained with Ehrlich's hematoxylin and eosin, or in some cases with Masson's trichrome, Mallory's triple or Heidenhain's iron-hematoxylin. Both longitudinal and transverse sections were always made.

Method of Illustration

The drawings of ant proventriculi used throughout this paper are of two distinct types.

The first of these consists of three-dimensional semi-diagrams of the whole cuticular framework of the proventriculus. The camera lucida drawings on which these illustrations are based were made as follows. With the proventriculus submerged in cedar oil in a small dish placed under the dissecting microscope, the fine, drawn-out end of a glass capillary needle was introduced into the proventriculus through the point of interseetion of the slit-like anterior openings (portal) of the organ. The opposite end of the needle was held in a universal joint by means of which the glass needle could be turned and the proventriculus oriented in the desired way. The hollow glass needle draws in the oil by capillarity, and in so doing becomes almost transparent and does not hide any of the structural details of the proventriculus. Camera lucida drawings were made with 15x ocular and 6x objective. The histological serial sections were of aid in filling in some of the more inconspicuous structural detail, not seen through the dissecting microscope.

In some of those few proventriculi studied in which the cuticular framework is excessively thin and flaccid, usually losing its shape in the absence of the supporting musculature (the ponerine, cerapachyine, doryline, and myrmicine representatives, and to some extent also the aneuretines and pseudomyrmecines), the drawings are in large part reconstructions based on the serial sections, and are labelled as diagrams.

With the exception of the conspicuous rugae on the outer margins of the plicae of the bulb, no effort was made in any of these drawings to represent the finer details of cuticular sculpturing. Wherever possible, these details were represented in the histological drawings discussed below.

For the purpose of clarifying some of the internal intricacies of the proventriculi, the cuticular framework is occasionally

represented with certain sections cut away. The depiction of the cutaways was based on the serial sections.

The second type of illustration consists of semi-diagrams of selected histological cross sections and longitudinal sections through the proventriculus, and were made with the aid of a camera lucida.

Due to the variety of fixatives used, the material served only for gross histological study, and lacked the uniformity necessary for comparative cytological observations of any value. The illustrations are therefore semi-diagrammatic, inasmuch as no attempt was made to represent intracellular detail. In a limited number of cases the only histological sections obtained were oblique, rather than transverse or longitudinal, and the drawings represent reconstructions from camera lucida outlines of the oblique sections. Wherever such reconstruction was employed, the drawings are labelled as *diagrams*.

The outstanding difficulty encountered in the interpretation of the histological sections was raised by the outermost longitudinal muscle fibers of the proventriculus (*l.m. 3* or similarly disposed fibers). These fibers usually consist of only a few scattered strands, which during histological processing may shrink away from their insertions on the cuticle, thereby becoming easily displaced, especially since they often lack the support of other tissues and lie free in the hemocoel. Tracing such muscle fibers through successive sections was difficult at best and sometimes impossible.

PART II

TYPES OF FORMICID PROVENTRICULI

MYRMECIOID COMPLEX

Subfamily MYRMECIINAE

Myrmecia Fabricius

Species examined: *M. regularis** Crawley, *M. piliventris* F. Smith, *M. nigrocincta* F. Smith, *M. vindex** F. Smith, *M. forficata** (Fabricius).

* An asterisk is used herein to denote those proventriculi which were sectioned histologically. A lack of an asterisk indicates that only cuticular framework preparations were made.

The proventriculus of *Myrmecia* is one of the least specialized among that of ants, and in most major respects it is similar to that of the few other aculeate hymenopterous families in which the organ has been described.

The cuticular framework (Fig. 4) consists of a thin-walled, flask-shaped *bulb* (*bl.*), opening anteriorly through a wide, roughly cruciform *portal* (*pt.*). The walls of the bulb are four broad, sclerotized, inwardly-curved plates, joined basally and merging into the slender, tubular *stomodaeal valve* (*st. vlv.*). The plates are separated one from another by relatively narrow longitudinal strips of thin, flexible cuticle, the pleats or *plicae* (*pl.*). The plates themselves are here termed *interplicaries* (*interpl.*). The interplicaries extend free beyond the plicae and the portal to project into the lumen of the crop as four apically rounded lobes or *quadrants* (*qd.*), collectively constituting the *cupola* (*cp.*). Actually, the cruciform shape of the portal is determined by the presence of the cupolar quadrants. The inner sclerotized surface of the quadrants is covered with relatively sparse short pile (Figs. 10, 12).

The bulb is surrounded by a strongly developed layer of circular muscles (Figs. 10, 13, 14; *c.m.*). With the exception of the innermost fibers, which insert on the lateral margins of the plicae, the circular muscles envelop the bulb without attachment to the cuticle.

The longitudinal muscles are arranged in three distinct groups (Figs. 10, 12, 13, 14; *l.m.1*, *l.m.2*, *l.m.3*). The most strongly developed of these (*l.m.1*) extends over the interplicary cuticle of the bulb, originating posteriorly near the base of the bulb and inserting anteriorly on the quadrants of the cupola. A second group (*l.m.2*) inserts along the posterior half of the interplicary plates, pierces the circular muscles, and fans out to become a part of the longitudinal musculature of the midgut. The third group (*l.m.3*) consists of only a few scattered fibers that insert on the quadrants, and extend posteriorly over the circular muscles to become continuous with *l.m.2*.

It proved impossible to determine the exact fate of those longitudinal muscles that approach the bulb from the crop, although the preparations suggested that these fibers distribute themselves among the various intrinsic muscles of the proventriculus (see dotted lines, Fig. 10).

In the arrangement of its longitudinal muscles, the *Myrmecia* proventriculus is unique: all other ant proventriculi examined, with the possible exception of *Pseudomyrmex*, *Aneuretus* (see next below) and some genera of the Poneroid complex, lack the *l.m.2* fibers.

A longitudinal section through the stomodaeal valve and associated structures (Fig. 11) shows how the extremely thin and flexible cuticular intima of the valve extends far into the lumen of the midgut and then turns inside out and back upon itself so as to form a compound tube. A strong muscular sphincter embraces the valve at the point of emergence from the bulb. Figure 11 is of interest also in that it shows in histological detail the nature of the foregut-midgut junction. Attention is called to the conspicuous columnar cells (*a*) grouped as a ring around the stomodaeal valve at the point where the latter perforates the midgut. The nature of these cells becomes clear from the work of Dobrovsky ('51) who has shown that in *Apis* these cells form a continuous barrier that separates the foregut from the midgut during the course of prepupal reorganization. At this time the developing stomodaeal valve is held back as an invagination within the bulb, and it is not until later that the cellular barrier is pierced by the intrusion of the valve into the midgut. A point of incidental interest is that the *basement membrane* (*b.m.*), which is strongly eosinophilic and readily traced, forms a continuous sheet over the foregut and midgut epithelium.

In all other ant proventriculi, the stomodaeal valve is essentially similar to that of *Myrmecia*, and except for some minor (but functionally significant) variation in the degree of development of the muscular sphincter (see page 478), no further consideration will be given to the stomodaeal valve in subsequent proventriculi.

My interpretation of the function of the *Myrmecia* proventriculus is as follows. The circular and longitudinal muscles act as antagonists to one another in compressing and expanding the bulb. By the combined action of the various longitudinal fibers, the interplicary plates of the bulb first spread apart from one another with the unfolding of the plicae, and then are flattened out. The quadrants of the cupola separate, and crop fluid is admitted through the widened portal into the expanded bulb. A forward flow of liquid from the midgut is prevented by the

stomodaeal valve, the thin wall of which collapses under the pressure of the midgut contents. By the contraction of its circular muscles, the bulb is then compressed and its contents forced back through the stomodaeal valve into the midgut. Backflow to the crop is hindered by the tight closure of the cruciform portal (approximation of the quadrants) and by a tight folding of the membranous plicae, closed by the circular fibers along their margins.

In addition to its function as a one-way valve, the stomodaeal valve undoubtedly serves also as a flexible, self-adjusting link, which by bending is capable of adjusting to peristalsis and volume changes of the crop.

The proventriculus of *Myrmecia* apparently is no better adapted to serve as a dam for the crop than is that of other Hymenoptera. It is evident from the structure of the organ that prolonged damming is possible only if either the cruciform portal or the stomodaeal valve is maintained tightly occluded under sustained muscular contraction. In preserved proventriculi of all *Myrmecia* species examined, the portal was always seen to be slightly agape, suggesting that sustained occlusion is maintained exclusively at the level of the stomodaeal valve, which in this genus is provided with a particularly powerful sphincter.

Subfamily PSEUDOMYRMECINAE

Pseudomyrmex Lund

*Species examined: P. pallidus** (F. Smith).

In its principal features, the proventriculus of *Pseudomyrmex* (Fig. 5) is similar to that of *Myrmecia,* and it can be safely assumed that it functions in much the same way. In *Pseudomyrmex* the quadrants of the cupola are shaped to fit together more closely at the axis, resulting in a more narrow cruciform portal, and a more compact cupola.

The *Pseudomyrmex* material available was in such a poor state of preservation that exact delineation of the longitudinal musculature was impossible. Although the presence of *l.m.1* and *l.m.3* fibers could be determined with certainty (Figs. 15, 16), there remains some doubt concerning the presence of *l.m.2.* A few fibers, strongly suggestive of *l.m.2* were seen in cross sections to

extend through the circular muscles at the level of the posterior third of the bulb (see *l.m.2* (?), Fig. 16), but final proof of the presence of *l.m.2* must await further investigation.

Subfamily ANEURETINAE

Aneuretus Emery

*Species examined: A. simoni** Emery.

In all of its major features, this proventriculus (Fig. 6), like that of *Pseudomyrmex*, conforms closely to that of *Myrmecia*.

The *l.m.1* and *l.m.3* fibers are fully retained (Fig. 21). Although I found no evidence for the presence of *l.m.2* fibers, I must admit that some uncertainty remains regarding their absence; the small size of the proventriculus, and the rather poor condition of the preparations available, made precise observations difficult.

In view of the overall structural similarity of this proventriculus with that of *Myrmecia* and *Pseudomyrmex*, its function is probably also much the same.

Subfamily DOLICHODERINAE

Hypoclinea Mayr

*Species examined: H. pustulata** (Mayr).

The cuticular framework of the proventriculus of *Hypoclinea* (Fig. 7), although distinctive in its ovoid bulb and flattened dome, still conforms to the basic structural plan of *Myrmecia*, *Pseudomyrmex*, and *Aneuretus*, except that the plicae have become sclerotized toward the base of the bulb.

Histologically, the longitudinal musculature has undergone a simplification by the loss of *l.m.2* (Fig. 17). In *Hypoclinea* this could be ascertained with certainty. Only *l.m.1* and *l.m.3* are retained (Figs. 17-20). As will be recalled, the main function of *l.m.2* in *Myrmecia* is to expand the bulb by pulling outward on the interplicary plates. With the sclerotized posterior parts of the plicae, the base of the bulb in *Hypoclinea* forms a cup of uninterrupted relatively thick cuticle, capable of elastic expansion by itself when the circular muscles relax. *L.m.2* has therefore become superfluous and is lost. The *l.m.1* and *l.m.3*

fibers serve mainly to disengage the cupolar quadrants so as to open the bulbar portal during the intake phase of proventricular activity, and from their attachment, it can be seen that they play no major part in the expansion of the bulb itself. Except for the fact that bulb expansion has become a passive process, the action of the *Hypoclinea* proventriculus is probably similar to that of *Myrmecia*.

Leptomyrmex Mayr

*Species examined: L. pallens** Emery, *L. cnemidatus* Wheeler.

The proventriculus of *Leptomyrmex* (Fig. 9) has become specialized in several major respects. The cupola is characteristically concave in its anterior aspect. The bulb is relatively small, and occupies less than the posterior half of the proventriculus. In the anterior half, the interplicary plates are thickened and pinched inward so as to frame a narrow cruciform tract, the *occlusory tract* (*occ. tr.*), an inward extension of the cruciform portal of the cupola. The entire occlusory tract and cupola are lined with dense, long, pile (Figs. 23, 24).

The walls of the occlusory tract are still articulated laterally by thin, flexible plicae, but as the occlusory tract opens posteriorly into the bulb, the plicae lose their membranous character and thicken to become sclerotized and hollow (C-shaped in cross section), reinforcing the bulb at its four angles.

Histologically, *Leptomyrmex* resembles *Hypoclinea* in that *l.m.2* is absent, and only *l.m.1* and *l.m.3* are retained (Figs. 23, 24, 25).

In its pumping action, the proventriculus of *Leptomyrmex* resembles that of *Hypoclinea* inasmuch as the bulb, being laterally reinforced by sclerotized plicae, is so constituted as to expand through its own elasticity. The longitudinal muscles serve only to widen the occlusory tract (the walls of which are allowed to separate by the flexibility of the plicae), thereby opening the pathway by which fluid enters the bulb.

In the acquisition of an occlusory tract we see in *Leptomyrmex* the first major specialization serving to improve the damming potential of the proventriculus. The extensive, relatively narrow, and densely pilose occlusory tract would seem capable by itself of effectively containing to a large extent the posteriorly

directed pressure exerted by the crop contents. Thus, the need for muscular force in the maintenance of proventricular occlusion has become somewhat reduced, and the efficiency of the damming action of the proventriculus correspondingly increased.

Liometopum Mayr

Species examined: L. sp.* (near *apiculatum* Mayr).

Although superficially *Liometopum* (Fig. 8) is quite distinct from *Leptomyrmex,* its general structural plan betrays its debt to a stock common to these two genera. Like *Leptomyrmex Liometopum* has an extensive occlusory tract, and the bulb itself is considerably reduced in size. Both the occlusory tract and cupola bear dense, long pile (Fig. 22). In contrast to that of *Leptomyrmex,* the cupola of *Liometopum* is broad and convexly reflexed, and is somewhat more rigid in consistency than any previously discussed. The plicae of *Liometopum* are, as in *Leptomyrmex,* fully sclerotized at the level of the bulb. Unlike in *Leptomyrmex,* the plicae are also somewhat thickened at the level of the occlusory tract, although they undoubtedly still retain sufficient flexibility to be readily unfolded when the occlusory tract is dislodged during bulbar intake. The ready mobility of the occlusory tract is clearly evidenced by prying with a glass needle. The muscles (Fig. 22) are arranged as in *Leptomyrmex.*

In its pumping action, *Liometopum* cannot differ grossly from *Leptomyrmex.* Some improvement might be afforded by the more rigid reflexed cupola, which acts to assure a passively maintained intrusion of the anterior proventriculus into the crop and thereby provides greater freedom of access to the cruciform portal. In the genera discussed previously, superficially similar intrusion of proventriculus into crop is also seen, but in these the texture of the cupola is largely membranous, and its intrusion seems to be maintained entirely by the tension of those longitudinal muscles extending from the crop over the proventriculus.

In its action as a dam, the *Liometopum* proventriculus shows some improvement over that of *Leptomyrmex,* in that the occlusory tract is provided with somewhat sclerotized and therefore spring-like plicae, serving as adjuncts to the circular muscles in sealing the occlusory tract.

Tapinoma Förster

*Species examined: T. sessile** (Say).

The proventriculus of *Tapinoma* (Fig. 26) is much more specialized in structure than any of the proventriculi discussed so far. It is a strong, rigid, subglobose structure, consisting of a well-developed bulb surmounted by a cupola made of thick, strongly sclerotized cuticle. The face of the cupola is ornamented with a characteristic, raised, densely pilose reticulum (Figs. 27, 28). This sculpturing extends inward to line the slit-like cruciform portal. This portal opens almost immediately into the bulb, and does not proceed farther inward to form an extensive occlusory tract as in *Leptomyrmex* and *Liometopum*. The bulb itself is characterized by the extreme rigidity and c-shaped cross sections of the plicae (Figs. 26, 29).

The longitudinal musculature has undergone some new specialization (Figs. 27, 29). One group of fibers, consisting of only a few strands, joins the margins of the cupola to the sides of the bulb. On the basis of their position inside the circular muscles, I consider these fibers as homologues of *l.m.1* of previous proventriculi; from these they differ only in their more peripheral insertion on the cupola. A second group of longitudinal fibers inserts anteriorly on the crop intima, in such a way as to maintain the posterior fold surrounding the proventriculus, and originates posteriorly on the base of the bulb near the origin of the stomodaeal valve. This was the first proventriculus studied in which the full course of these fibers, including origin and insertion, could be traced with ease. Possibly they are homologues of *l.m.3* that have shifted their insertion outward to the crop intima and have taken posterior origin secondarily on the bulb. This interpretation is reasonable, in view of the absence of any other obvious *l.m.3* homologues in *Tapinoma*. There exists, in fact, some evidence that in previously discussed proventriculi, the outermost components of *l.m.3* are in a similar wise already fold-maintaining fibers, but in these cases origin and insertion could usually not be made out, and the fibers seemed to extend from the crop over the proventriculus without attachment to the cuticle. In view of the uncertainty that remains concerning the identity of these fibers in *Tapinoma,* and

subsequent dolichoderines having similarly placed fibers, they are labelled as *l.m.3*(?).

In its function as a dam, *Tapinoma* shows significant improvement over previous proventriculi. In the resting proventriculus, the quadrants of the cupola are rigidly maintained in the adducted position and the portal orifice is held to a narrow slit by the spring-like reinforcement of the strongly sclerotized plicae. *Here is seen the first instance in which proventricular damming is probably accomplished without any muscular reinforcement whatsoever.*

The structural advances in the *Tapinoma* proventriculus are, of course, linked closely with functional changes in the pumping action. The restriction of the portal orifice to a narrow slit tends to handicap the ingress of fluid during bulbar intake, and it becomes necessary to widen the portal through a disengagement of the cupolar quadrants. *Tapinoma* lacks an effective occlusory tract, and only a minimal dislocation of the quadrants suffices for the ready access of fluid into the bulb. I believe, in fact, that a wide disengagement of the quadrants is not only unnecessary but impossible. The thickness and rigidity of the cupola and the full sclerotization of the bulbar plicae (these acting as spring antagonists to the quadrant retractor muscles (*l.m.1*)) speak for a very narrow range of mobility of the quadrants. The narrowness of this range is further demonstrated by the resistance to displacement of the portal when a glass needle is inserted. It is interesting to note in this connection that *l.m.1* inserts on the rim of each quadrant, thereby achieving optimal leverage.

When the circular muscles contract, the bulb is compressed and fluid is forced back into the midgut in the usual fashion. Backflow into the crop is prevented by a maximal compression of the cruciform portal and a tight engagement of its pilose lining. During the subsequent relaxation of the circular muscles, the bulb expands under the intrinsic elasticity of its cuticular framework. In this expansion, the spring-like plicae play an important role. Simultaneously, the portal orifice is forced slightly agape under tension from *l.m.1,* and crop fluid rushes into the newly emptied and now expanding bulb.

Azteca Forel

*Species examined: A. sp.** (common ochraceous species from Vera Cruz, Mexico), *A. instabilis* (F. Smith).

Although in general shape, constitution of the bulb and arrangement of the musculature, the proventriculus of *Azteca* (Fig. 30) seems close to that of *Tapinoma*, it has certain features that suggest that it may stand alone as an evolutionary offshoot.

The cupola is unique in that the four quadrants are each deeply and angularly excised, lending the cupola a characteristic cruciform shape in frontal view. In section, the strongly sclerotized cuticle of the cupola is seen to possess an inner zone composed of closely approximated cuticular hairs which give it a finely and evenly striated appearance. These hairs extend inward along the cruciform portal to line a short occlusory tract. In possessing this tract, *Azteca* further differs from *Tapinoma*.

In musculature (Fig. 31) the *Azteca* proventriculus does not differ greatly from that of *Tapinoma*. Emery (1888) claimed a complete absence of longitudinal muscles in *Azteca instabilis* (F. Smith), but he probably just missed them.

The *Azteca* proventriculus at rest is maintained in the occluded state by its intrinsic elasticity in much the same way as in *Tapinoma*, and it can therefore also serve effectively as a passive dam to the crop. Its damming action is, in fact, improved over that of *Tapinoma*, owing to the presence of the occlusory tract.

Although obvious structural similarities render it likely that the proventriculus of *Tapinoma* and *Azteca* function in much the same way, it is not clear to me whether, during the active intake phase of bulb operation in *Azteca*, there is a full disengagement of the cupolar quadrants, or whether disengagement is damped as in *Tapinoma*. In *Azteca*, the presence of an occlusory tract may offer sufficient resistance to the inflow of fluids to make its opening necessary. The angular excision of each quadrant may confer greater flexibility upon the cupolar portal arrangement, thus facilitating the action of the strong "retractors" (*l.m.1*) found in *Azteca*. Further evidence for mobility of the occlusory tract is demonstrated by its relatively easy displacement when a glass needle is introduced.

The five genera *Forelius, Dorymyrmex, Turneria, Froggattella*, and *Iridomyrmex* are unmistakably related on the basis of

proventricular structure. In this series, the proventriculus achieves its highest degree of specialization among the Dolichoderinae. An understanding of the structural intricacies of these proventriculi is perhaps best accomplished by considering first the most complex proventriculi of the series (*Iridomyrmex, Froggattella, Turneria*) and then their more simple evolutionary relatives (*Dorymyrmex, Forelius*).

Iridomyrmex Mayr

*Species examined: I. detectus** (F. Smith), *I. viridiaeneus** Viehmeyer, *I. punctatissimus* Emery, *I. nitidus* Mayr.

The proventriculus of *Iridomyrmex* (Figs. 32, 44, 45) features a broad, strongly reflexed cupola with involuted margins, holding tightly within its hollow a greatly reduced bulb. (Caste dimorphism is displayed in the relative development of cupola and bulb; in the female caste, the bulb is slightly larger, and barely projects from beneath the cupolar shell.)

The cupola is primarily divided into four quadrants by the cruciform portal in the usual fashion. A major new development is the secondary division of the quadrants, each of which is split radially by a narrow *phragma* (*phr.*).

The external cupolar cuticle is covered by dense, fine, short pile (Figs. 34, 35), extending into the cruciform portal. A similar pilose vestiture, but slightly longer, was already seen to cover the cupola of *Azteca*.

Each arm of the cruciform portal opens into a vestibular cleft or *sinus* (Figs. 32, 35; *sin.*), which in turn communicates with the mesial lumen of the bulb via a submedian zone of construction (Figs. 32, 35; *a*). The zones of construction are secondary developments within the bulb proper that have arisen in response to a functional need to be discussed below. The bulb is further characterized by the subdeltoid cross section of the plicae.

Histologically, the proventriculus is seen to lack all intrinsic longitudinal muscles (Figs. 34, 35). There remain only those fibers (*l.m.3*) that maintain the posterior fold of the crop surrounding the cupola.

An outstanding advance in *Iridomyrmex* is the complete encasement of the bulb within the rigid, reflexed cupola, a circumstance that tends to render the bulb motionbound. This handicap

has been overcome by the development of the cupolar phragmata, which act as flexible radial hinge-lines, allowing the cupolar segments to yield inward to the contraction of the bulb. The powerful development of the circular muscles (Figs. 34, 35) reflects the added burden imposed on the bulb by the need for embowing the cupolar segments during bulbar contraction. The bulbar expansion that follows is activated not only by the intrinsic elasticity of the bulb itself, but also by the cupolar segments, which, after becoming embowed during bulbar contraction, spring back to their original position and carry along the walls of the bulb.

The necessary development of radial hinge-lines, however, brings with it a new difficulty. During bulbar contraction, the lateral arms of the cruciform portal tend to be forced open by the contraction of the circular muscles (see Fig. 35) instead of becoming occluded, as would be the case if the cupolar quadrants were not pleated. It therefore has become necessary to develop a secondary valve seal in the form of the constriction zones within the bulbar lumen. During bulb contraction, the four constriction zones close early in each pumping cycle, and serve to prevent leakage from bulb to crop.

Since *Iridomyrmex* has lost all intrinsic longitudinal muscles, it is incapable of actively expanding the cruciform portal during bulb expansion. The need for such expansion is avoided by the reduction of bulb size (relative to portal orifice) and also because resistance to inflow is minimized in the absence of an occlusory tract.

This proventriculus is ideally suited to serve as a passive dam. The very narrow, densely pilose portal, maintained immobile by the rigid bracing of the bulbar core within the cupola, acts as an effective plug guarding the outlet of the crop; fluid can probably be forced inward past the portal only under suction pressure exerted by the bulb.

Froggattella Forel

Species examined: F. kirbyi (Lowne).

TURNERIA Forel

*Species examined: T. sp.** (near *pacifica* Mann, collected by E. O. Wilson in New Hebrides, 1954-1955).

In these two genera the proventriculus is identical in all respects to that of *Iridomyrmex*. Caste dimorphism is again manifested in the slightly longer bulb in the female.

DORYMYRMEX Mayr

*Species examined: D. ensifer** Forel.

On the basis of the proventriculus, *Dorymyrmex* (Figs. 42, 43) may be considered close to the direct evolutionary antecedent of *Iridomyrmex*.

In *Dorymyrmex*, unlike *Iridomyrmex*, the posterior third of the bulb, constituting the most voluminous and therefore the contractile portion of the bulb proper, is free and projects from beneath the cupolar shell. Each cupolar quadrant is, as in *Iridomyrmex*, incised by radial hinges or phragmata, but incision is incomplete and stops considerably short of the cupolar summit. As in *Iridomyrmex*, the cupola and portal bear short dense pile, and the plicae of the bulb are subdeltoid in cross section. There is no trace of intrinsic longitudinal muscles, and there persist only those fibers (*l.m.3*) that sustain the circumcupolar fold of the crop (Fig. 37, representing a longitudinal section through the proventriculus of *Conomyrma*, may be taken also to represent *Dorymyrmex*). *Dorymyrmex* has not acquired the secondary valve-seal mechanism provided in the bulb of *Iridomyrmex* in the form of submesial zones of constriction.

From a functional standpoint, one can readily explain the incipient condition of quadrant incision, and the lack of a secondary valve-seal mechanism in the bulb. Both of these conditions are, in fact, directly attributable to the incompleteness of the envelopment of bulb by cupola. First of all, the fact that most of the contractile portion of the bulb projects from beneath the cupola, thereby remaining largely unimpeded in its operation, obviates the need for a complete radial incision of the quadrants. Only the rim of the cupola must yield to bulbar contraction, and consequently only the rim is incised. Secondly, since the quadrants are only incompletely pleated, it is still

possible to accomplish a valve-seal at the level of the portal during bulbar compression, and no secondary valvular mechanism had to be acquired.

In its action as a passive dam, the *Dorymyrmex* proventriculus presents the same structural advantages as that of *Iridomyrmex*.

Forelius Emery

*Species examined: F. foetidus** (Buckley).

In its basic plan, the proventriculus of *Forelius* (Figs. 40, 41) is just about what would be expected of a precursor member of the *Dorymyrmex-Iridomyrmex* line. *Forelius* displays in incipient form the outstanding feature of this line, namely the envelopment of the bulb by the cupola; most of the bulb is free, and only the anterior third is encased within the cupola. Relative to the cupola, the bulb is much larger in *Forelius,* than it is in *Dorymyrmex* and *Iridomyrmex. Forelius,* like *Dorymyrmex,* shows a beginning of cupolar pleating: only the margins of each quadrant are interrupted by phragmata. The subdeltoid outline of the plical cross section and the short dense evenly-distributed pile of the cupolar face and portal, characteristic of both *Dorymyrmex* and *Iridomyrmex,* are already fully developed in *Forelius.*

Histologically, the picture presented by the longitudinal muscles is puzzling (Fig. 36). The most conspicuous fibers (*l.m.?*) insert on the underside of the quadrants *outside* the circular muscles, bend posteriorly around the circumcupolar fold of the crop, and fan out anteriorly over the crop. These fibers would seem to represent a newly captured component of the proventricular musculature, possibly representing crop fibers that have secondarily inserted on the cupola. A single fiber (see *?*, Fig. 36) is shown as a remnant of *l.m.1.* A question mark has been used to denote this fiber, since its presence is not of general occurrence, and I have, in fact, seen it only as a single fiber in one of the three proventriculi sectioned longitudinally (all were workers of the same nest series). This variation in the presence of *l.m.1* points to *Forelius* as an evolutionary stage in the *Dorymyrmex-Iridomyrmex* line at which *l.m.1* has become totally superfluous and is disappearing. Longitudinal fibers,

similar in position to *l.m.3* of previous proventriculi are present in *Forelius*.

Although its general structural affinities to *Dorymyrmex* suggest that the *Forelius* proventriculus functions in much the same way, there remains to be found a fully satisfactory explanation of the function of the unique longitudinal muscles (*l.m.?*) of *Forelius*. In view of their insertion on the underside of the quadrants, their obvious function would appear to be quadrant disengagement and portal widening. The general rigidity of the cupola (evidenced again in this genus by resistance to displacement when a glass needle is inserted through the portal) would, of course, preclude anything but the narrowest margin of cupolar mobility, and the most that the muscles can accomplish is a minimal distention of the portal slits (in much the same way as in *Tapinoma*). But why has portal distention become a necessity in *Forelius* when it is obviously superfluous in the basically similar proventriculi of *Dorymyrmex* and *Iridomyrmex*? The answer lies in the relatively larger size of the *Forelius* bulb, the undistended portal of which offers an insufficient intake orifice during bulbar expansion. One may ask why *Forelius* did not retain a fully developed set of *l.m.1* to accomplish portal distention instead of acquiring a completely new set of muscles, but careful examination of Figure 36 shows that *l.m.1*, due to its adaxial position, would be ill-suited to accomplish quadrant retraction even if strongly developed.

The following two genera (*Conomyrma* and *Technomyrmex*) have much in common with the *Forelius-Dorymyrmex-Iridomyrmex* line, but certain unique characteristics of their own suggest their phyletic divergence from this series.

Conomyrma Forel

*Species examined: C. thoracica** Santschi

Conomyrma, in common with *Forelius*, *Dorymyrmex* and *Iridomyrmex*, shows a partial envelopment of the bulb by the cupola, the degree of involvement being intermediate between that of *Forelius* and *Dorymyrmex* (Figs. 33, 46, 47). The cupolar cuticle bears short dense pile, and the bulbar plicae are subdeltoid in cross section (Figs. 37, 38, 39). *L.m.1* fibers are totally lacking, and there are present only those longitudinal

fibers (*l.m.3?*) that maintain the circumcupolar fold of the crop.

Conomyrma differs from the *Forelius-Dorymyrmex-Iridomyrmex* series in that it has no phragmata to interrupt the strongly convex, evenly selerotized surfaces of the quadrants. The four convex quadrants, separated by the recessed lines at the arms of the portal, produce a four-lobed or somewhat clover-leafed pattern in frontal view (Fig. 47).

The "yielding lines" in the cupola, needed to allow bulbar contraction, coincide with the arms of the cruciform portal. The elastic arch formed by each quadrant confers the necessary flexibility to allow recession at the "yielding lines" during bulbar contraction. The placement of the "yielding lines" at the portal slits also ensures a tight closure of the latter during contraction of the bulb, and this closure acts as an efficient valve opposing backflow. Thus, by means of a relatively simple variation in the cupolar plan, the *Conomyrma* proventriculus has avoided the development of phragmata and the ensuing difficulties that had to be met with in *Iridomyrmex* by the acquisition of a secondary valve-seal in the bulb.

Technomyrmex Mayr

*Species examined: T. detorquens** (Walker) (=*albipes* F. Smith).

This proventriculus (Figs. 48, 49) is so similar to that of *Conomyrma* in the major features of its framework that one is bound to assume that it functions in identical fashion.

Technomyrmex, like *Conomyrma,* has acquired arched quadrants as a means of conveying flexibility to the cupola; the arching is more pronounced than in *Conomyrma* and affords a distinguishing character.

Emery (1888) and Forel (1878) have already pointed to the unique sculpturing manifested by the *Technomyrmex* cupola. In *T. detorquens* this sculpturing takes the form of a reticulum of hexagonal units (Fig. 49), raised on the *underside* of the cupola. My preparations suggest (although not with certainty) that the hexagonal units delimit the areas of cuticular deposition of the individual underlying epithelial cells. Emery interprets the reticulum, not as a surface sculpturing, but as an intracuticular labyrinth; it is likely that he was led to an erroneous

interpretation by the obliquity of his sections.

Technomyrmex differs from *Conomyrma, Forelius, Dorymyrmex,* and *Iridomyrmex* in that the bulbar plicae are not subdeltoid, but C-shaped in cross section (Fig. 49). This feature, the unique type of cupolar sculpturing, and also divergent external characters of the whole ant that have long been recognized by taxonomists (Brown, W. L., personal communication) point up the possibility that the form and function of the *Technomyrmex* proventriculus may have developed along an independent line. In this case, the proventriculi of *Technomyrmex* and *Conomyrma* would have to be counted as a striking instance of convergent evolution.

Subfamily FORMICINAE

Among the formicine genera, the proventriculus falls far short of developing the heterogeneity of types we have seen to occur in the Dolichoderinae. In fact, all Formicinae possess either one or the other of two basic types of proventriculi, with relatively slight variation, except for the very few known species, belonging to only one or two genera, in which the proventriculus is of intermediate character. The two main types, with the intermediates, seem to express a simple evolutionary progression from the more generalized *asepalous* type to the advanced *sepalous* type. From among many possible examples, the two described here in detail as representative of asepalous (*Notoncus*) and sepalous (*Camponotus*) types were chosen because of their relatively large size and because adequately preserved material happened to be available.

Asepalous Formicine Proventriculus

NOTONCUS Emery

*Species examined: N. ectatommoides** (Forel).

The cuticular framework (Fig. 50) consists of cupola and bulb, both characterized by extreme sclerotization and rigidity.

The cupola, unlike that of any dolichoderine proventriculus, is not hollowed out, but consists of a thick solid cuticular cap roofing the frontal aspect of the bulb. The face of the cupola is

flattened in *Notoncus* (but domed in many other asepalous formicine genera) and frames a narrow cruciform portal. The portal continues inward through the cupola in the form of a narrow occlusory tract, except for the outer extremities of the arms of the portal, each of which is immediately adjacent to the upper extension of its respective plicary canal (Figs. 53, 55-58). The face of the cupola, the cruciform portal, and the occlusory tract all bear short, densely approximated pile, similar to but longer than that found in the advanced dolichoderine proventriculi. The cruciform portal and occlusory tract are rigidly braced by the massive cupolar quadrants; it is impossible to pry open the portal with a glass needle without cracking the bulbar framework.

The bulb itself is marked externally by the four prominent plicae, one at each corner. The plicae are heavily sclerotized and c-shaped in cross section, so that the lumen of each one forms a distinct *plicary canal* (*pl. cn.*). Posteriorly, the bulb merges into the stomodaeal valve in much the same way as in all other proventriculi, by a posterior constriction and sudden thinning of the cuticle.

The proventriculus of *Notoncus,* like that of probably all the other asepalous formicine genera, is peculiar in that it does not intrude into the crop in dolichoderine fashion, but is actually prevented from such intrusion by a constriction of the crop immediately in front of the cupola (*precupolar constriction:* Figs. 53, 54, *precp. const.*).

Histologically, *Notoncus* has undergone some striking innovations (Figs. 53, 55-58). The circular muscles are most strongly developed around the bulb, and at this level they do not differ significantly in their arrangement from those of previously discussed proventriculi: the innermost fibers insert along the plicae, while the peripheral fibers envelop the bulb without cuticular attachments. Anteriorly, the circular muscles extend past the cupola to form a relatively strong sphincter surrounding the precupolar constriction of the crop. In this arrangement the *Notoncus* proventriculus differs from all previously discussed proventriculi, in which, it will be recalled, the strongly developed circular musculature terminates abruptly at the anterior extremity of the bulb, whence it continues as a loose network of fibers over the crop.

The principal group of longitudinal muscles (Fig. 53) I consider, on the basis of their position inside the circular muscles, as homologues of *l.m.1* of previous proventriculi. These fibers originate on the interplicary cuticle of the bulb and extend anteriorly to insert, *not on the cupolar quadrants*, as in previous proventriculi, but on the crop intima of the precupolar constriction, in such a way as to act as antagonists to the sphincter surrounding the constriction (some fibers apparently fail to insert on the cuticle and extend anteriorly over the crop; see Fig. 53).

Outside the circular muscles there is present, as usual, a second rather weakly developed group of longitudinal fibers. I am tentatively homologizing these with *l.m.3* of previous proventriculi, although their anterior insertion on the crop intima could not be verified with certainty in *Notoncus*.

Thus we see that the most important modifications of the musculature of the asepalous formicine proventriculus are correlated, on the one hand, with the loss of portal mobility, and on the other with the acquisition of the precupolar constriction. The development of a rigid immobile portal eliminated the need for longitudinal muscles of the kind needed for quadrant disengagement. The muscles were not lost, however, as occurred in the higher dolichoderines with similarly immobile portals; a shift of their anterior insertion engaged them instead with the operation of the precupolar constriction of the crop.

In its function as a dam, the asepalous formicine proventriculus presents the same advantages as that of the higher dolichoderines, inasmuch as the portal orifice is permanently reduced to a narrow, immobile and densely pilose slit, rigidly braced by the sclerotized cupola and plicae. Its damming function is actually improved over that of the advanced dolichoderine proventriculus by the presence of the occlusory tract.

It is in the pumping action of the proventriculus, and specifically in the mechanics of ingress past the cruciform portal and occlusory tract, that we find in *Notoncus* a functional deviation from previous proventriculi.

It will be recalled that almost the entire occlusory tract is by-passed at its four corners by an anterior extension of the plicary canals. These four tips apparently constitute the principal incurrent pathways, since they represent the points of least resistance to inflow. In conformity with this functional plan,

the occlusory tract is densely pilose, while the canals have naked walls. In this method of ingress, the *Notoncus* proventriculus differs from the dolichoderine proventriculi with similarly immobile portals. In these, there are no structurally differentiated pathways of resistance through the portal; resistance to inflow, and therefore rate of inflow, is generally distributed over the entire portal.

Following is my interpretation of the pumping action of the proventriculus. As the bulb cavity collapses under muscle contraction, the contents are forced back through the cylinder into the midgut. The entire occlusory tract becomes maximally occluded through a tight engagement of its pilose lining, and thus acts to bar backflow into the crop. Also, as the bulb starts its contraction, its four plicary canals are sealed off by approximation of their inner edges, perhaps imperfectly in the posterior portion, but at least completely enough to act as an auxiliary valve to prevent most of its contents from flowing back and forcing their way through the portal tips.

As the circular muscles relax and the bulb cavity expands due to the elasticity of its cuticular framework, the original narrow orifice of the cruciform portal is restored. Simultaneously the plicary canals open again into the bulb lumen and communicate the bulbar suction to the tips of the portal. Undoubtedly, some liquid is sucked in also through the occlusory tract, but this portion is so extensive and densely covered with hairs that traffic through it must be minor as compared to that through the lateral canal system.

What is the function of the precupolar constriction? If we follow the basic assumption that the longitudinal muscles contract alternately with the circular muscles, it is apparent that the constriction opens and the cupola is uncovered to project freely into the crop just at the time when bulb expansion has initiated fluid inflow through the portal. Thus, the opening of the constriction acts as a pump in itself, inasmuch as it assures the transfer of crop fluid to the immediately antecupolar lumen of the crop, and this function is probably especially important when the crop contains only small amounts of fluid. An additional function of the precupolar constriction is suggested below, on page 480.

Melophorus Lubbock

Species examined: M. sp.* probably *ludius* Forel), *M. bagoti* Lubbock.

The outstanding peculiarity of *Melophorus* is to be found in the cupola (Fig. 52), the face of which is slightly depressed in the center and protuberant at its four corners. Otherwise, both in its cuticular framework and arrangement of the muscles (Figs. 59-61), the proventriculus does not differ grossly from *Notoncus.*

Acropyga Roger

*Species examined: A. myops** Forel (or species near, collected by W. L. Brown, Blackall Range, S. E. Queensland, Australia, 1951).

Anoplolepis Santschi

Species examined: A. longipes (Jerdon), *A. custodiens* (F. Smith).

Acantholepis Mayr

Species examined: A. frauenfeldi (Mayr).

Diodontolepis Wheeler

Species examined: D. hickmani (Clark).

The proventriculi of these genera (Figs. 51, 64, 65) resemble one another on the basis of the strongly convex shape of the cupola. *Diodontolepis,* which has not been illustrated herein, bears very close resemblance to *Anoplolepis.* Histologically, only *Acropyga* (Figs. 62, 63) was examined, and except for minor structural peculiarities, such as the extreme thickness of the plical walls, there were found no specializations in the arrangement of the muscularis to suggest a functional deviation from *Notoncus.* All these genera have a precupolar constriction like *Notoncus.*

Myrmoteras Forel

Species examined: M. williamsi Wheeler.

The single dried specimen that was available of this rare

species revealed a distinctly peculiar proventriculus (Fig. 66), unique among those of asepalous formicines in the flattened and cruciform aspect of the cupola, and in the elongate and posteriorly tapering shape of the bulb. (Histologically preserved specimens of this genus have recently been collected by Dr. E. O. Wilson and should be available shortly to amplify the present study.)

Sepalous Formicine Proventriculus

(Figure 67, a diagrammatic representation of the sepalous proventriculus, should be used as a reference throughout this section.)

Camponotus Mayr

*Species examined: C. vicinus** Mayr, *C. americanus** Mayr, *C. herculeanus* (Linnaeus).

In the camponotine proventriculus (Figs. 67, 68, 70-74), the obvious distinctive character, here met for the first time, is a long anterior extension called the *calyx*, consisting of four heavily sclerotized strap-like cuticular arms, or *sepals* (*sep.*), extending anteriorly from the bulb to capture part of the posterior wall of the crop. (Sexual dimorphism is manifested in all sepalous proventriculi by the slightly longer calyx in the female.)

The sepals may be thought of as the anterior drawn-out bulbar plicae of an asepalous precursor, that have carried along in their extension the four corners of the cupola with their enclosed portal tips. Each sepal is seen to contain a cylindrical canal, the *sepal canal* (*sep. cn.*) (continuous posteriorly with the plicary canal of the bulb), that communicates along its entire length with the lumen of the calyx through a narrow and densely pilose longitudinal cleft (*pt.*) representing an extended arm of the cruciform portal. On their luminal surface, the sepals are covered with dense short pile (Fig. 71) similar to that lining the cupolar face of asepalous formicine proventriculi. The sepals themselves are joined by means of membranous sheets of *intersepalary cuticle* (*intersep.*), continuous with and of the same texture as the intima of the crop wall proper.

Posteriorly, the sepals curve together and fuse medially at the level of the occlusory tract. In the structure of the occlusory tract and bulb, *Camponotus* does not differ grossly from asepalous proventriculi, and the rigid c-shaped plicae are again so constituted that the canals they enclose merge with the bulb lumen by way of a zone of constriction that can be sealed off during bulb compression (Fig. 74).

Only relatively minor changes have occurred in the muscularis (Figs. 70-74). The *l.m.1* fibers are seen to originate on the interplicary cuticle of the bulb, and extend anteriorly past the occlusory tract, at which point the inner fibers become inserted on the intersepalary cuticle, while the few remaining outer fibers continue anteriorly without cuticular attachments past the calyx and over the crop. Attention is called to the inward fold of the intersepalary cuticle at the bottom of the calyx (Fig. 70, *a*), and into which insert the *l.m.1* fibers. This fold is undoubtedly all that remains in this proventriculus of the precupolar constriction of an asepalous ancestor.

Outside the circular muscles, a few scattered longitudinal fibers extend from crop to midgut (Fig. 70, *?*), apparently bypassing the proventriculus without cuticular attachments. Probably these fibers contain only the usual crop-to-midgut fibers, although it is possible that they are joined by homologues of *l.m.3* of previous proventriculi, that have here become detached from the cuticle. In other sepalous formicine genera (see *Formica* next below) the muscles differ in their arrangement.

In its action as a pump, this proventriculus remains essentially the same as its asepalous antecedent. The principal difference between the two types lies, of course, in the sepalary development and its functional consequences. In asepalous formicine proventriculi, the presence of an occlusory tract — although a distinct asset to the function of the proventriculus as a dam — considerably restricts the portal area available for bulbar intake. Only the outermost tips of the portal, being immediately adjacent to the anterior extensions of the four plicary canals that by-pass the occlusory tract, remain as pathways for fluid ingress. *Camponotus* and the other sepalous formicines have successfully exploited a means of increasing the bulbar intake area by extending, in the form of the calyx, both the plicary canals and their associated portal tips. Thus, the calyx is to be regarded, not as

an adjunct to the damming function of the proventriculus, but as a further refinement of the proventriculus as a pump. The damming potential has, however, been retained, since increase in portal area is accomplished without *widening* the portal at any point.

During bulb contraction, when fluid is being evacuated from the bulb through the stomodaeal valve, backflow through the occlusory tract is prevented by the tight engagement of its opposing pilose linings. Simultaneously, the potential backflow route through the plicary and sepalary canals is closed (or nearly closed) by the meeting of the edges of the grooves through which canals and bulbar lumen communicate. When the bulb recovers by means of elastic expansion, the grooves are reopened, and the lumen again communicates with the canals, initiating a new inflow through the sepalary portal slits. As in the asepalous formicines, it seems that a small amount of fluid must also enter directly through the occlusory tract at the stage of expansion; however, the length, narrowness, dense vestiture and extremely restricted mobility of the four clefts forming the tract surely reduce such inflow to a negligible quantity, especially when one considers the opportunity for fluid ingress offered by the portal-plus-canals.

Emery (1888) believed the calyx to function exclusively as a valve that, by sustained occlusion, acts to relieve the proventriculus of fluid pressure from the crop. He disregarded the possibility that the principal intake system of the bulb might be routed through the sepals. He believed that the pilose lining of the portal clefts actually seals off the sepal canals from the calyx cavity: "Die Rinne wird gegen das Lumen des Kelches durch das Ineinandergreifen der die Flugel besetzenden Härchen verschlossen." Accordingly, he was inclined to treat the sepals as relatively unimportant structures. Subsequent workers, including Forbes ('38), have observed that the canals really open into the lumen, but not until recently (Eisner and Wilson '52) has the possibility been considered that they might serve to conduct fluid past the occlusory tract.

Brief mention should be made at this point of an incidental, but probably significant function of the calyx. It is likely that during bulbar activity the calyx undergoes pulsations synchronous with those of the bulb, being alternately constricted by its

circular muscles and expanded by the elastic spring-like action of the sepals. During calyx expansion, crop fluid tends to be drawn into the calyx lumen, thereby assuring an adequate supply of the bulb just at the time when bulb expansion initiates fluid intake through the sepalar-portal arrangement. Thus, while increase of intake area was the principal evolutionary justification for the appearance of the calyx, it seems that it came to function also as an analogue of the precupolar constriction of asepalous proventriculi.

It is doubtful that the *l.m.1* fibers play any significant contributory role in the expansion of the calyx, since they insert, not on the sepals themselves, but on the loosely folded and flaccid intersepalary cuticle. Furthermore, in other sepalous formicines (*Formica*), the similar structure of which suggests no great functional divergence from *Camponotus, l.m.1* has been lost entirely. I regard *l.m.1* in *Camponotus* as a mere remnant persisting from an asepalous antecedent in which the function of *l.m.1* was, as in *Notoncus*, the dilation of the precupolar constriction.

Formica Linnaeus

Species examined: F. sp.* (*fusca* group), *F. subnuda* Emery (*sanguinea* group).

Aside from obvious but relatively minor differences in the shape of the bulb and calyx, *Formica* (Figs. 69, 75, 100-103) differs significantly from *Camponotus* only in the arrangement of the longitudinal muscles (compare Figs. 70 and 75). *L.m.1* is entirely absent. There is present, outside the circular muscles, a group of longitudinal fibers that insert anteriorly on the crop intima so as to maintain a circumsepalar fold of the crop (Fig. 75); I am tentatively homologizing these fibers with *l.m.3* of previous proventriculi. In *Camponotus* (Fig. 70) no such circumsepalar fold was found, and the scanty outermost longitudinal muscles of the proventriculus extend from crop to midgut without apparent cuticular connections.

Figures 76-84 illustrate a variety of the forms of cuticular framework found among different sepalous formicine genera, included here chiefly because of their taxonomic interest. The features of each type as known at this time are clear from the

figures, and the individual cases require no discussion. (In *Myrmecocystus* (Fig. 79) the tips of the sepals curve outward only in the worker; in the female they are straight.)

Proventriculi were examined for a number of additional genera, but since each of these closely resembles one of the genera figured, it will suffice here merely to list the correspondences. *Gigantiops destructor* (Fabricius), *Dendromyrmex chartifex* (F. Smith), *Opisthopsis haddoni* Emery, and *Polyergus breviceps* Emery resemble *Formica*. *Polyrachis dives* (F. Smith) is similar to *Camponotus*. *Pseudolasius mayri* Emery closely resembles *Lasius*.

Although such characters as the shape of bulb and plicae and length of the sepals may in themselves be valuable phyletic indicators, it is hoped that the internal evolutionary relationships of this series will be further clarified by future work, and especially by a comparative histological analysis of the longitudinal musculature. The possibility should not be lightly dismissed that a major phylogenetic divergence may be outlined by the presence or absence of *l.m.1*, as exemplified in this study by *Camponotus* and *Formica* respectively.

Proventriculi with Incipient Sepals

Cladomyrma Wheeler

Species examined: C. hewitti Wheeler.

Only two dried specimens, a queen and a worker, probably nestmates, were available for study of this very rare genus. The proventriculus of the queen (Fig. 85) shows an incipient but nevertheless distinctly typical calyx, and on this basis *Cladomyrma* would seem to represent a survivor of the ancestral stock that gave rise to the higher sepalous formicines. Sexual dimorphism is strikingly exemplified in this genus by the *complete absence of a calyx in the worker*, the proventriculus being endowed with a typical asepalous cupola.

Myrmecorhynchus André

Species examined: M. emeryi André.*

Although distinctly suggestive of an incipient sepalar condition (Fig. 86), other peculiarities of the proventriculus, as well

as characteristics of the whole ant (W. L. Brown, and E. O. Wilson, personal communication), point to the possibility that *Myrmecorhynchus* may stand apart as an evolutionary offshoot, having acquired its sepal-like structures by convergence.

The bulb is more capacious than usual (Fig. 89), and the occlusory tract is not reduced to a narrow impassable cleft as in other formicines, but is seen to be held agape (Fig. 88), suggesting that bulbar intake is generally distributed over the entire portal and occlusory tract instead of just at the tips. Most probably, this widening of the occlusory tract developed in response to the increase in bulbar capacity. The cruciform portal also differs from other formicines in that it lacks the usual pilose vestiture.

In its musculature, *Myrmecorhynchus* is like *Notoncus*. The precupolar constriction and *l.m.1* are well developed and probably still functional.

PONEROID COMPLEX

Only very few representatives of this complex, including one or two genera of each of the four major subfamilies currently recognized (Brown '54), were examined for the present study. In part this was due to the lack of properly preserved material, an especially unfortunate handicap here since the relative uniformity of the cuticular framework of the poneroid proventriculus forces one to turn to the arrangement of the muscles in the search for phyletic indicators. The aberrant subfamily Leptanillinae could not be studied at all; I did not succeed in recovering a proventriculus from the single dried specimen that was available to me.

Subfamily PONERINAE

ODONTOMACHUS Latreille

*Species examined: O. haematoda** (Linnaeus), or near.

In its principal features (Fig. 90), the proventricular framework conforms to the general plan of *Myrmecia*. The bulb is elongate and posteriorly tapering. Only the interplicary plates are somewhat sclerotized; the plicae themselves are thin and flaccid. The cupolar quadrants are globose, and diverge from

one another, framing a widely gaping cruciform portal. The presence of *l.m.1* and *l.m.3,* similarly arranged as in *Myrmecia,* could be determined with certainty. The apparent absence of *l.m.2* is not to be taken as conclusive, since my preparations were inadequate.

Both in its pumping action and damming potential, the proventriculus of *Odontomachus* probably resembles that of *Myrmecia.*

Amblyopone Erichson

*Species examined: A. australis** Erichson.

This proventriculus (Fig. 91) is strikingly unique among those of ants, and possibly all other Hymenoptera, in that it deviates from the basic quadripartite plan. The cupolar quadrants, portal arms, plicae, and interplicary plates are six in number, instead of the usual four. Except for this remarkable feature, *Amblyopone* does not differ greatly from *Odontomachus.* The cupolar quadrants are more closely approximated, and do not diverge apically as in *Odontomachus.* The plicae are membranous, and the entire proventriculus is weakly sclerotized and flaccid. The material available was poorly preserved, rendering impossible an exact delineation of the longitudinal musculature. The *l.m.1* fibers are grouped into six separate bundles instead of the usual four, each bundle following the course of its corresponding interplicary plate.

The structural peculiarities of *Amblyopone* do not suggest any major functional deviations. Its function, like that of *Odontomachus,* is probably similar to that of *Myrmecia.*

Amblyopone is generally agreed to be one of the most primitive of all living ants. The distinct peculiarities of its proventriculus point up the possibility that *Amblyopone* may actually be more highly specialized than previously suspected.

Subfamily CERAPACHYINAE

Phyracaces Emery

Species examined: P. dumbletoni Wilson.

Although distinctive in its barrel-shaped bulb (Fig. 92), the

proventriculus of *Phyracaces* conforms to the structural plan of *Myrmecia,* and presumably functions in a similar way. The presence of *l.m.1* and *l.m.3,* arranged as in *Myrmecia,* was determined with certainty, but there remains some doubt about the apparent absence of *l.m.2.*

Subfamily MYRMICINAE

Pogonomyrmex Mayr

*Species examined: P. occidentalis** (Cresson).

The cuticular framework (Fig. 95) consists of an elongate, extremely flaccid and funnel-shaped "bulb," devoid of a cupola, merging anteriorly with the crop through a gradual expansion of its lumen. Although the wall of the bulb is produced into four inward folds, vaguely delimiting plicary and interplicary regions (Fig. 96), there are no textural differences between these regions, the cuticle being evenly membranous throughout. The circular muscles are strongly developed as usual, but have lost all cuticular connection. The exact course and homologies of the longitudinal muscles could not be determined. The principal group of fibers, extending as four bundles along the inward folds of the bulbar cuticle, are strongly suggestive of *l.m.1.*

It is difficult to explain the functional implications of the obviously degenerate condition of this proventriculus. The loss of an anterior valve-seal, elsewhere provided by the cupola, and the loosely-folded membranous condition of the bulbar cuticle, speak for a radical departure from the usual fluid pumping action. It may well be that this type of proventriculus has become modified to yield to the passage of solid matter, forced through the bulb under muscular pressure. This possibility deserves further attention, especially since the myrmicines are known for their unusual feeding habits, several genera commonly partaking of seeds and other vegetable material.

The structural divergences of the *Pogonomyrmex* proventriculus would not seem to have reduced its capacity as a dam, since the membranous bulb is readily occlusible under muscular contraction.

Forel (1878) and Emery (1888) called attention to the highly aberrant proventriculus of the myrmicine tribe Cephalotini. This proventriculus has re-acquired a cupola, in the form of a rigid

and elaborately ornamented umbrella, that abuts a typical funnel-shaped and membranous myrmicine "bulb." The functional significance of this unusual cupolar development is obscure at present.

Hylomyrma Forel

*Species examined: H. columbica** Forel, or near.

This proventriculus is identical in all major respects to *Pogonomyrmex*.

Subfamily DORYLINAE

Eciton Latreille

*Species examined: E. hamatum** (Fabricius).

This proventriculus (Fig. 93), although closely resembling that of *Pogonomyrmex*, appears to have progressed even further in its degeneration, the folding of the bulbar cuticle being completely randomized and irregular (Fig. 94). This proventriculus is, in fact, nothing but a stomodaeal valve, preceded by a muscularly maintained constriction of the posterior wall of the crop.

The same functional speculations advanced for *Pogonomyrmex* apply to *Eciton*, except that the latter is wholly predaceous.

THE STOMODAEAL VALVE

Except in *Myrmecia*, where it was described in considerable detail, no emphasis has been granted to the stomodaeal valve in the various other proventriculi. The valve is, in fact, the most uniform constituent of the ant proventriculus, and the only structural modifications that seem to have functional overtones occur in the degree of development of the muscular sphincter that surrounds the neck of the valve at the point where it pierces the midgut.

In *Myrmecia*, as well as in all other generalized proventriculi with divergent cupolar quadrants and a mobile portal (pseudomyrmecines, ponerines, and cerapachyines), the sphincter is strongly developed, and probably serves in maintaining an occlusion of the neck of the valve when the resting proventriculus prevails in its function as a dam. In all the higher dolichoderines

and formicines, in which proventricular damming is accomplished passively by an elastically maintained occlusion of the cupolar or sepalar portal arrangement, the need for sustained occlusion at the level of the stomodaeal valve has been lost, and the sphincter surrounding the neck of the valve has accordingly become reduced, sometimes consisting of not more than a single layer of fibers.

IDENTITY OF THE "SEKRETSCHICHT" OF EMERY (1888)

Emery granted some emphasis to the fact that the cupola of most dolichoderine proventriculi seen by him (*Tapinoma, Technomyrmex, Forelius, Conomyrma* (=*Dorymyrmex* Emery *nec* Mayr), *Bothriomyrmex* and *Iridomyrmex*) is tightly overlain by a discrete layer or "membrane" of varying thickness. Emery assumed that this layer, which he called in its different forms *Sekretschicht, Sekrethäutchen,* or *Sekretblättchen,* was a deposit secreted by the cupolar epithelium. He found no such layer present in *Azteca, Liometopum, Leptomyrmex,* or tribe Dolichoderini. Among the formicines, Emery found the layer present in *Camponotus ligniperdus,* but makes no mention of it in the two asepalous genera he examined, *Plagiolepis* and *Brachymyrmex.*

In the histological preparations made for this work, a dense layer, more or less unevenly granulose in texture (Fig. 98), was found covering the cupola or sepals of the following genera:

Dolichoderinae: *Forelius, Dorymyrmex, Iridomyrmex, Turneria, Conomyrma, Technomyrmex.*

Formicinae: *Camponotus, Formica.*

The layer varied considerably in thickness, even among nestmates. Structurally, it showed considerable differentiation from genus to genus, particularly in texture and in staining reaction; in some cases the layer was weakly basophilic, in others totally refractory to the stains used.

There was no trace of a layer in *Myrmecia, Pseudomyrmex, Aneuretus, Tapinoma,* and members of the poneroid complex. In *Azteca, Liometopum,* and *Leptomyrmex,* as well as in all genera of asepalous Formicinae that were sectioned (*Notoncus, Melophorus,* and *Acropyga*), there was present no compact

layer, but the cupolar hairs held some clustered particles in loose irregular arrangement (Fig. 99).

It is evident that the degree of development of the layer is closely correlated with the amplitude of portal mobility. With the notable exception of asepalous formicines, a *compact* layer is present only in those proventriculi endowed with an immobile slit-like portal. Given this correlation, my interpretation of the "Sekretschicht" is that it is most likely not a secreted structure, but merely a filtration aggregate consisting of those small particles that, having escaped the withholding action of the infrabuccal chamber and the filtration devices within the buccal cavity, have massed on the cupolar or sepalar surfaces, held back by the filtering guard hairs of the proventricular portal.

There remains to be explained the absence of the layer in the asepalous formicines. The precupolar constriction may afford this explanation, considering its probable action of sweeping the cupolar face repeatedly during the pumping cycle (see under *Notoncus*, p. 468).

One apparent inconsistency in this hypothesis is the difference found between *Tapinoma* and *Forelius*, despite the similar functions proposed for these genera insofar as their damped portal opening is concerned. *Tapinoma sessile* lacked the filtrate layer in my preparations, while my *Forelius* possessed the layer in a well-developed form. The probability that the portal does open would at first glance seem to render difficult the accumulation of sufficient filtrate to form a layer, but the degree to which this opening is damped in these two genera actually makes it more surprising that *Tapinoma* lacks the layer than it does that *Forelius* has it.

As noted above, Emery found the layer present in *Tapinoma*, but in a different group of the genus, in *T. melanocephalum* (Fabricius). Absence of the layer in my *Tapinoma* could be taken as a sign that my interpretation of proventricular function is incorrect, and that the portal really opens more widely than seems possible in view of the cupolar rigidity. However, the structural qualities of the *Tapinoma* proventriculus lead me to believe that the lack of a filtrate layer in my limited samples is either a histological artifact or else reflects a lack of particulate dietary constituents in these specimens, all drawn from a unicolonial series.

PART III

DISCUSSION

One of the organs long used in ant classification is the proventriculus, a structure in which major changes are largely concordant with subfamily, and even with many tribal breaks based primarily on other structural characters. It is this concordance that renders proventricular structure such a valuable indicator of phylogeny within the ants, and at the same time affords a basis for checking evolutionary steps in proventricular modification. Even at the generic level, the proventriculus so far as known offers no serious contradiction to presently accepted classifications, and the deeper one probes into the details of musculature and other components, the more new useful information the organ yields for the systematist.

In Figure 97, a dendrogram is based on the structural relationships of the known proventriculi as revealed by the present study, and interpreted in the light of the most recent phyletic schemes. It will be necessary to refer to this figure in following the discussion below.

The outstanding feature of the adult hymenopterous digestive tract is the crop, a stomodaeal food reservoir acquired in adaptation to the relatively discontinuous feeding habits characteristic of these insects (Bischoff '27). The proventriculus is essentially a structure accessory to the crop, and in this capacity serves both as a *dam,* capable of containing the pressure exerted by the liquid crop contents, and as a *pump,* regulating the delivery of fluid to the midgut. It consists of a flexible but strongly-muscled bulb, the pump, with intake and exhaust valves provided respectively by the cupolar portal, and the stomodaeal valve. The stomodaeal valve is embraced by a sphincter, the sustained contraction of which presumably effects the dam.

This simple type of proventriculus is well suited to the habits of the solitary Hymenoptera, the crop of which stores food for its own use, or at the most for the use of itself and its mate (Given '54).

With the acquisition of social habits and division of labor, the burden of securing, transporting and transmitting food falls entirely upon a part of the adult population. The brood, re-

productives, and non-foraging workers are more or less continuous consumers of food, but contribute little or nothing to the larder. There thus arises a necessity for a storage system — a necessity accentuated under unfavorable environmental conditions. Honeybees, for instance, solve this storage problem by means of the comb, a communal storehouse external to their own bodies.

In the ants, such storage facilities as exist, at least for fluids, are usually limited to the crops of the individual workers. The storage of amounts of fluid far in excess of the needs of the individual worker, and for protracted periods of time, places a strain on the arrangements by which damming depends upon sustained muscular contraction of the stomodaeal valve sphincter. Any structural changes tending to relieve the load of the sphincter are therefore at a premium, especially if these changes can shift the load to a passive barrier.

The generalized formicid proventriculus

In the lower ants (Ponerinae, Cerapachyinae, Myrmeciinae, Pseudomyrmeeinae, and Aneuretinae) the proventriculus is similar in all major respects to that of the other Hymenoptera so far studied. Proventricular damming is probably maintained exclusively by the stomodaeal valve sphincter, which in these ants is especially well produced. The bulb is a flaccid structure with gaping portal, incapable in itself of plugging the crop. Damming is therefore a dynamic, energy-consuming process. This basically inefficient mechanism limits the full exploitation of the social functions of crop storage and regurgitative feeding. Indeed, recent work emphasizes the fact that in these primitive ants, regurgitative feeding is still in its incipient stages (Le Masne '53, Haskins and Whelden '54). None of these ants is known to have "replete" castes.

Dolichoderinae and Formicinae

In the advanced dolichoderines (tribe Tapinomini) and all formicines, proventricular damming no longer depends upon the continuous muscular pressure of the stomodaeal valve sphincter, and the sphincter in these subfamilies is greatly reduced in size.

The damming function has shifted to the reinforced cupola, which now forms a rigid shield, pierced by a narrow, densely pilose cruciform slit, and capable by itself of stemming leakage from the crop. Damming is therefore accomplished passively, without expenditure of muscular energy. The evolution of the proventriculus in these subfamilies is the history of the elaborate and varied pathways of change along which the proventriculus adapted to its new function as a passive dam.

An early step in the evolution of the damming cupola is exemplified in the dolichoderines by the *Azteca-Tapinoma* proventricular type, and in the formicines by the *asepalous* type. Already these proventriculi have acquired the pilose portal slit, strongly braced by the sclerotized cupola and bulbar plicae, and able to hold back fluids when the inactive proventriculus prevails in its function as a dam. That these remarkably similar refinements arose convergently in the dolichoderines and formicines is attested by the differences in the arrangement of the longitudinal muscles and by other characters.

The restriction both in size of orifice and in mobility of the cupolar portal arrangement — although a distinct asset to the damming function of the proventriculus — tends to render the portal orifice inadequate for bulbar intake during the pumping cycle. This handicap is accentuated in *Azteca* and the asepalous Formicinae by the interposition, between portal and bulbar lumen, of an occlusory tract. In order to reconcile the basic pumping action of the bulb with the new damming qualities of the portal, *Azteca* and *Tapinoma* retain a limited range of portal mobility, the quadrants being slightly dislocated during bulbar intake under the action of *l.m.1* muscle fibers. Dislocation is damped, with the sclerotized bulbar plicae acting as spring antagonists to the retractor muscles. Unlike those of *Azteca* and *Tapinoma,* the asepalous formicine proventriculus can accomplish its pumping action without quadrant dislocation. It has, in fact, no muscles adapted to moving the quadrants, the *l.m.1* fibers having shifted their insertion away from the cupola itself to become concerned with the operation of the precupolar constriction of the crop. Bulbar intake is routed through the plicary canals, the anterior extensions of which by-pass the occlusory tract to join the four corners of the portal. This mechanism of ingress, although using only a relatively small portion of the

portal, must provide sufficient flow for the active pumping action of the organ.

The most advanced proventricular types of the dolichoderines (*Iridomyrmex, Dorymyrmex, Conomyrma,* and *Technomyrmex*) and formicines (*Camponotus,* and all other *sepalous* proventriculi), although differing radically in structure, are actually remarkably similar in their functional achievements. They retain the narrow slit-like portal attained by their respective evolutionary antecedents, and are therefore similarly adapted to serve as passive dams. In these proventriculi, the need for portal disengagement is completely eliminated, and the quadrant retractors (*l.m.1*) are entirely absent, or if retained, as is the case in some sepalous proventriculi (*Camponotus*), they are functionally impotent as retractors. The complete loss of portal mobility is coincident with certain structural refinements designed to increase the *portal orifice: bulbar capacity* ratio needed to assure adequate bulbar intake during the pumping cycle. In the dolichoderines this is accomplished by a reduction in bulbar capacity through progressive envelopment of bulb by cupola, a process shown in its incipient stage in *Forelius,* and culminating in *Iridomyrmex.* In the formicines, bulbar capacity remains unaltered, there being instead an increase in the portal orifice through anterior extension of the portal tips in the form of sepals. Since the portal is increased in *length* but not in *width,* its damming potential is not sacrificed. The development of sepals is seen in its incipiency in *Cladomyrma.*

Two relatively primitive dolichoderine genera, *Liometopum* and *Leptomyrmex,* having in common certain proventricular specializations unique among the dolichoderines, apparently represent one or two isolated and probably long-standing evolutionary offshoots. Both proventriculi feature an extensive occlusory tract, a distinct asset to the damming action of the proventriculus. Potentially, this occlusory tract tends to obstruct bulbar operation, but since it is articulated laterally by membranous plicae, it is easily opened by *l.m.1* during bulbar intake.

The adaptive significance of the passive-dam proventriculus of the dolichoderines and formicines is reflected by the full exploitation in these ants of the social functions of crop storage and regurgitative feeding (Le Masne '53). All ant genera known

to have "replete" castes are restricted to one or the other of these subfamilies.

Myrmicinae and Dorylinae

The proventriculus of the myrmicines (with the exception of the Cephalotini; see Emery 1888) and the dorylines has become degenerated to the point where it consists essentially of only a stomodaeal valve; the bulb is presumably non-functional as a pump, since it is reduced to a membranous and more or less irregularly folded constriction of the posterior crop. From the structure of the organ it is clear that proventricular damming is not a passive process, but must be dependent upon muscular contraction, at the level of the stomodaeal valve and/or the "bulb." Although regurgitative feeding is known to occur among some of these ants (*Crematogaster;* Wilson and Eisner '57) nothing is known about the length of time over which the crop can store nutrient. It is interesting to note in this connection that some myrmicines have become independent of the crop as the exclusive communal reservoir. Instead, they have developed a storage system outside their own bodies, hoarding seeds or other types of solid nutrient.

It may be relevant here to emphasize a major functional limitation of the passive-dam dolichoderine and formicine proventriculi. The complete loss of portal mobility, resulting from the acquisition of a rigid slit-like portal, would seem to preclude completely the transfer of any but the most minute particulate matter to the midgut. We have seen, in fact, that in the advanced dolichoderines, even minute particles are not always passed to the midgut, but actually accumulate over the cupolar face in more or less discrete layers. We have also seen that in the asepalous formicine proventriculi, such accumulation of particles does not take place, presumably being prevented by the sweeping action of the precupolar constriction of the crop.

It would be interesting to know whether, in all ants with a rigid slit-like portal, there has been an increasing dependence upon cephalic solid-withholding devices such as the infrabuccal chambers or the ridges of the buccal cavity mentioned by Wheeler ('10). It would even be worthwhile considering whether the refinement of such buccal particle-traps was a pre-

adaptation necessary for the evolution of the passive-dam proventriculus. There is much need for detailed observations on the feeding behavior of ants having such proventriculi. Just because an ant is seen feeding on a dead insect, for instance, does not mean that it is *swallowing* solid matter, since it may actually take in only the juices. One would even expect that small particles such as pollen grains, which are known to figure prominently as a source of protein in the diet of adult honeybees, are of too large diameter to be transferred through the passive-dam proventriculi.

The proventriculi with mobile portals, on the other hand, such as those of the myrmicines, pseudomyrmecines, aneuretines, ponerines, and cerapachyines (and, for that matter, of all other aculeate families in which the organ has been studied), are constructed in such a way that no hindrance would appear to be offered to the passage of at least small particles. Perhaps some lesser particles such as pollen grains actually constitute a staple source of protein in some of these ants. From the work of Bailey ('52) we know, for instance, that in *Vespa, Bombus,* and *Prosopis,* pollen suspensions do not choke the proventriculus and are effectively pumped to the midgut. In *Apis,* the proventriculus has certain structural peculiarities enabling it, at least under some circumstances, to strain out the pollen grains from the fluid crop contents and selectively transfer them to the midgut (Bailey '52, Schreiner '52). This type of activity, while probably incidental to the primary fluid-handling function of the proventriculus, may be of importance when the bee requires large quantities of pollen protein for the synthesis of brood-food secretion (Bailey '54). Whether any activity similar to the pollen-transfer action of the *Apis* proventriculus occurs in any of the ant proventriculi with mobile portals remains to be shown.

The proventricular structure of the dorylines and myrmicines (with the single known exception of the cephalotines) presents no obvious obstacle to the passage of even large particles, but we do not yet know whether these ants actually *swallow* solids. It would be interesting to know this, because it is not beyond possibility that the "degenerate" condition of the proventriculus in these ants is actually an adaptive response to changed feeding habits involving greater use of injested solids.

I am fully cognizant of the fact that the often elaborate functional schemes advanced here for the various proventricular types are largely speculative, and that future work may uncover fallacies in my reasoning. However, there is only one basic assumption underlying this study and for which I have no direct substantiating evidence, namely, that the circular muscles and longitudinal muscles contract alternately rather than simultaneously. Actually, it seems impossible to conceive of any workable proventricular mechanism based on a synchronous activity of these muscles. The other lines of reasoning used in connection with functional interpretations, such as evaluation of the relative effectiveness of the various muscles, are not completely speculative, since they are based in part on an estimation of the relative mobility of the various proventricular components that these muscles operate. Mobility of the cupolar quadrants, for instance, is readily disclosed by prying with a glass needle. Similarly, the elasticity of the bulb can be evaluated by observing its resilience under varying pressure directly applied.

It would be interesting to test the functional schemes advanced here by direct experimentation. I have not yet tried to evaluate the relative damming efficiency of the various proventricular types by determining 1) the amount of fluid that can be stored in the crop, and 2) the length of time over which storage can be maintained. However, such studies, and others along these general lines, are currently planned or already under way in this laboratory. The use of radioactive tracers appears to be especially promising. A preliminary investigation on the relative importance of regurgitative feeding in several representative species of ants is in press (Wilson and Eisner '57, Eisner and Wilson, '57).

LITERATURE CITED

Bailey, L.

1952. The action of the proventriculus of the worker honeybee, *Apis mellifera* L. J. Exp. Biol., **29:** 310-327.

1954. The filtration of particles by the proventriculi of various aculeate Hymenoptera. Proc. Roy. Ent. Soc. London, **A29:** 119-123.

Bischoff, H.

1927. Biologie der Hymenopteren. Springer Verlag, Berlin.

Brown, W. L.

1954. Remarks on the internal phylogeny and subfamily classification of the family Formicidae. Insectes Sociaux, **1:** 21-31.

Dobrovsky, T. M.
1951. Postembryonic changes in the digestive tract of the worker honeybee (*Apis mellifera* L.). Memoir, Cornell Univ. Agr. Exp. Sta., **301:** 3-45.

Eisner, T. and W. L. Brown
1957. The evolution and social significance of the ant proventriculus. Proc. Tenth Internat. Congr. Ent. (in press).

Eisner, T. and E. O. Wilson
1952. The morphology of the proventriculus of a formicine ant. Psyche, **59:** 47-60.
1957. Radioactive tracer studies of food transmission in ants. Proc. Tenth Internat. Congr. Ent. (in press).

Emery, C.
1888. Uber den sogenannten Kaumagen einiger Ameisen. Zeitschr. wiss. Zool., **46:** 378-412.
1912. Formicidae, subf. Dolichoderinae. Wytsman's Genera Insectorum, fasc. **137:** 1-50.
1925. Formicidae, subf. Formicinae. *Ibid.*, fasc. **183:** 1-302.

Forbes, J.
1938. Anatomy and histology of the worker of *Camponotus herculeanus pennsylvanicus* De Geer (Formicidae, Hymenoptera). Ann. Ent. Soc. Am., **31:** 181-195.

Forel, A.
1878. Études myrmécologiques en 1878 (première partie) avec l'anatomie du gésier des fourmis. Bull. Soc. Vaudoise Sci. Nat., **15:** 337-392.

Given, B. B.
1954. Evolutionary trends in the Thynninae (Hymenoptera: Tiphiidae) with special reference to feeding habits of Australian species. Trans. Roy. Ent. Soc. London, **105:** 1-10.

Haskins, C. P. and R. M. Whelden
1954. Note on the exchange of ingluvial food in the genus *Myrmecia*. Insectes Sociaux, **1:** 33-37.

Kennedy, C. H.
1949. Methods for the study of the internal anatomy of insects. Ohio State Univ., Columbus, Ohio.

Le Masne, G.
1953. Observations sur les relations entre le couvain et les adultes chez les fourmis. Ann. Sci. Nat. Zool., (11) **15:** 1-55.

PANTIN, C. F. A.
1948. Notes on microscopical technique for zoologists. Cambridge Univ. Press.

SCHREINER, T.
1952. Über den Nahrungstransport im Darm der Honigbiene. Zeitschr. vergl. Physiol., **34**: 278-298.

SNODGRASS, R. E.
1956. Anatomy of the Honey Bee. Comstock Publishing Associates (Cornell Univ. Press).

WHEELER, W. M.
1910. Ants, their structure, development, and behavior. Columbia Univ. Press.
1923. Social life among the insects. Harcourt, Brace and Co., New York.

WILSON, E. O. and T. EISNER
1957. Quantitative studies of liquid food transmission in ants. Insectes Sociaux (in press).

WILSON, E. O., T. EISNER, G. C. WHEELER and J. WHEELER
1956. *Aneuretus simoni* Emery, a major link in ant evolution. Bull. Mus. Comp. Zool. Harvard, **115**: 81-99.

KEY TO ABBREVIATIONS

The measurements given for proventricular length were taken between cupolar summit, or sepal tips, to the base of the bulb at the point of insertion of the stomodaeal valve.

All longitudinal sections show only one half of the proventriculus, and are taken through the interplicary cuticle of the bulb, midway between the plicae.

bl. ..... bulb
b.m. ..... basement membrane
c.m. ..... circular muscles
cp. ..... cupola
Cr. ..... crop
interpl. ..... interplicary plate of bulb
intersep. ..... intersepalary cuticle
l.m.1 ..... longitudinal muscles no. 1
l.m.2 ..... longitudinal muscles no. 2
l.m.3 ..... longitudinal muscles no. 3
M. G. ..... midgut

occ. tr. ..... occlusory tract
phr. ..... phragma
pl. ..... plica
pl. cn. ..... plicary canal
precp. const. ..... precupolar constriction
pt. ..... portal
pv. ..... proventriculus
qd. ..... quadrant
sep. ..... sepal
sep. cn. ..... sepal canal
sin. ..... sinus
st. vlv. ..... stomodaeal valve

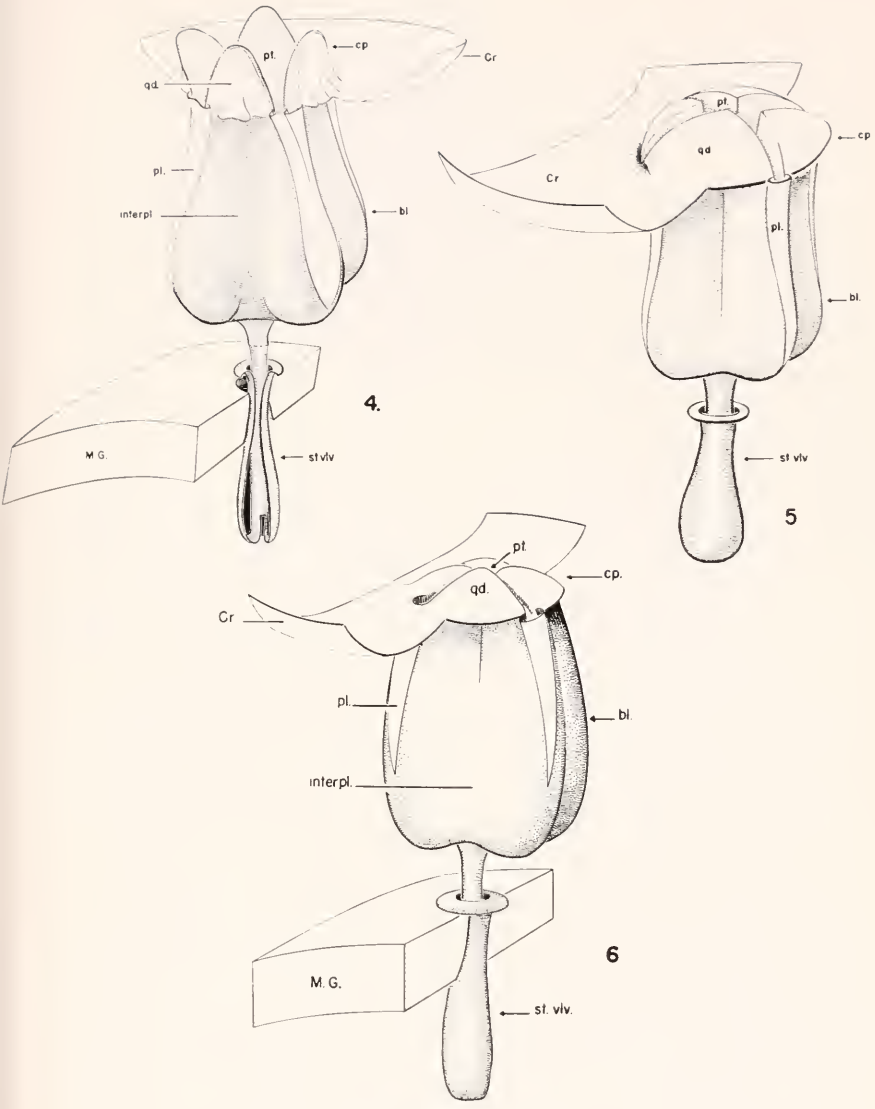
PLATES

PLATE 1

Fig. 4. *Myrmecia regularis* Crawley. Cuticular framework. (Worker; 0.40 mm.)

Fig. 5. *Pseudomyrmex pallidus* (F. Smith). Cuticular framework, diagrammatic. (Worker; 0.14 mm.)

Fig. 6. *Aneuretus simoni* Emery. Cuticular framework, diagrammatic. (Worker; 0.08 mm.)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6

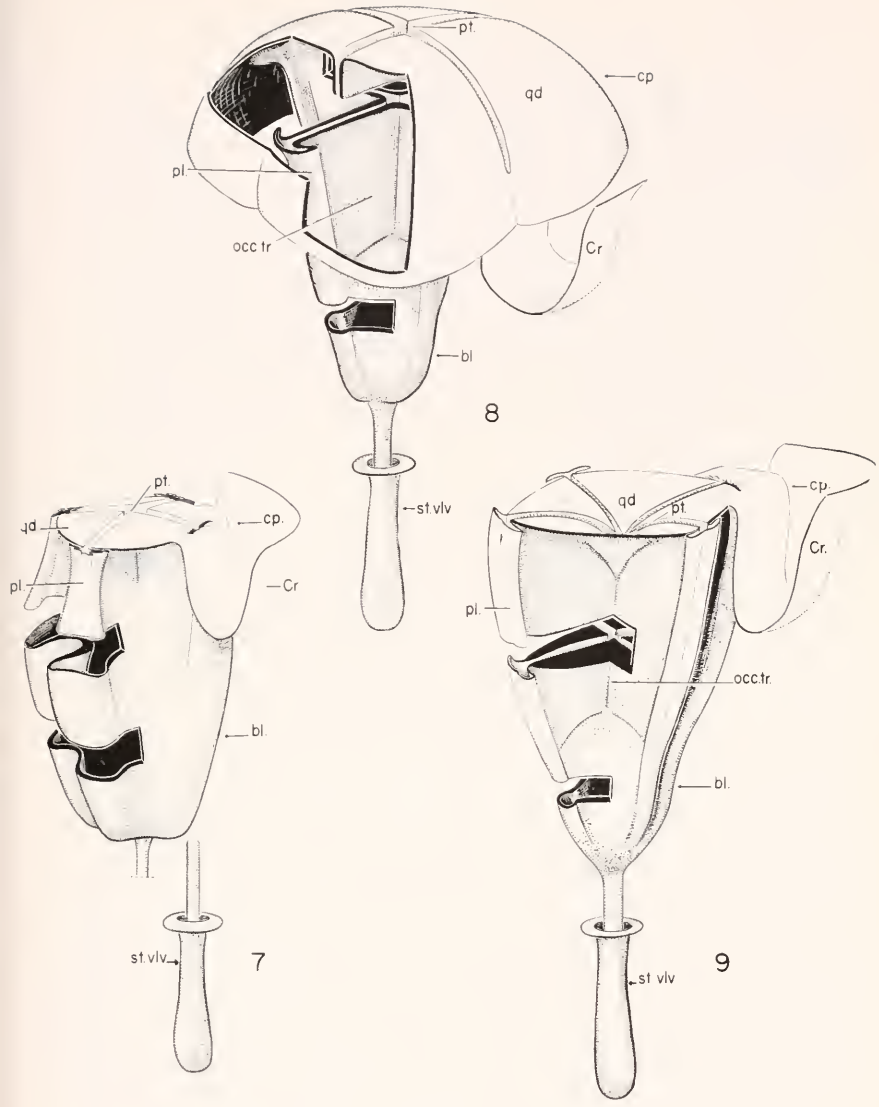
PLATE 1

PLATE 2

Fig. 7. *Hypoclinea pustulata* (Mayr). Cuticular framework. (Worker; 0.18 mm.)

Fig. 8. *Liometopum* sp. (near *apiculatum* Mayr). Cuticular framework. (Worker; 0.24 mm.)

Fig. 9. *Leptomyrmex excmidatus* Wheeler. Cuticular framework. (Worker; 0.44 mm.)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9

PLATE 2

PLATE 3

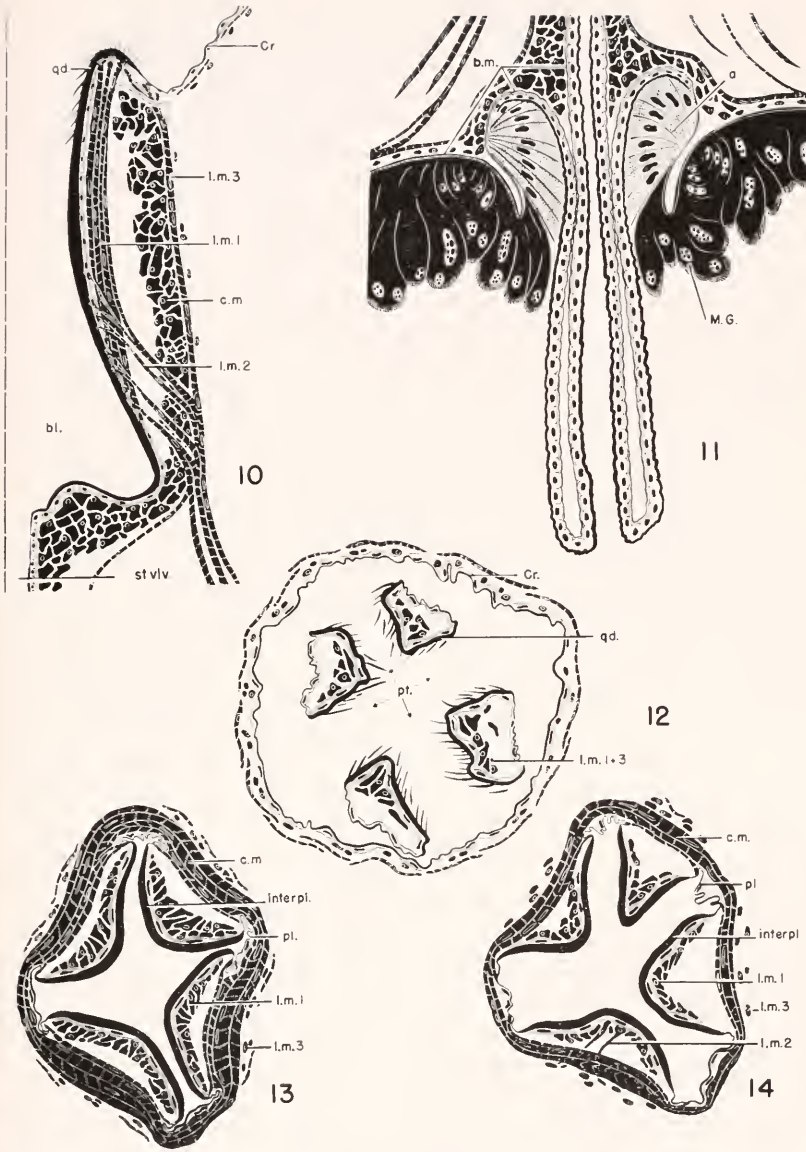
Fig. 10. *Myrmecia vindex* F. Smith. Longitudinal section through bulb and cupola.

Fig. 11. *M. regularis* Crawley. Longitudinal section through stomodaeal valve.

Fig. 12. *M. vindex* F. Smith. Cross section through cupolar quadrants.

Fig. 13. Same. Cross section through middle of bulb.

Fig. 14. Same. Cross section through posterior fifth of bulb.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pl
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l.m.1
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14

PLATE 3

PLATE 4

Fig. 15. *Pseudomyrmex pallidus* (F. Smith). Cross section through middle of bulb.

Fig. 16. Same. Cross section through base of bulb.

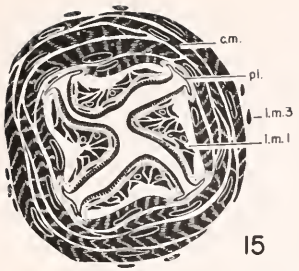
Fig. 17. *Hypoclinea pustulata* (Mayr). Longitudinal section through bulb and cupola (diagrammatic).

Fig. 18. Same. Cross section through cupolar quadrants.

Fig. 19. Same. Cross section through middle of bulb.

Fig. 20. Same. Cross section through base of bulb.

Fig. 21. *Ancuretus simoni* Emery. Longitudinal section through bulb and cupola.



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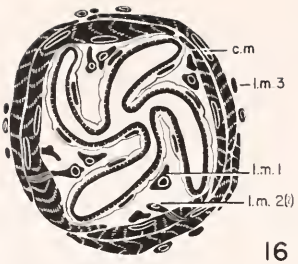

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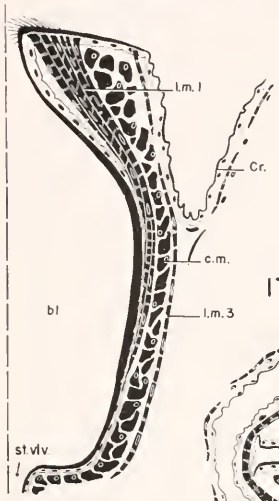

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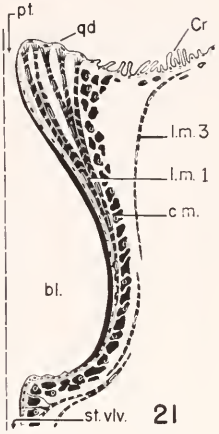

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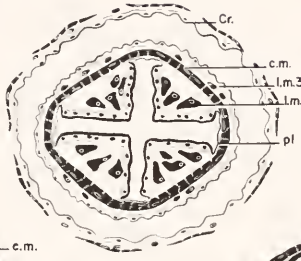

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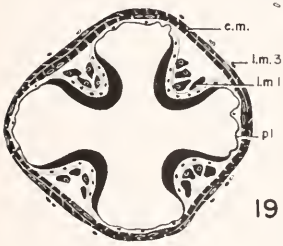

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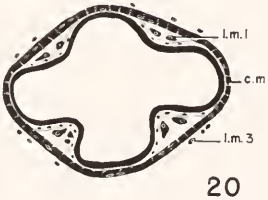

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PLATE 4

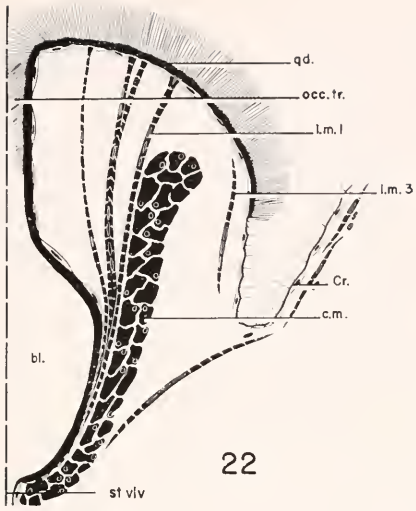
PLATE 5

Fig. 22. *Liometopum* sp. (near *apiculatum* Mayr). Longitudinal section through cupola, occlusory tract, and bulb (diagrammatic).

Fig. 23. *Leptomyrmex pallens* Emery. Longitudinal section through cupola, occlusory tract, and bulb.

Fig. 24. Same. Cross section through middle of occlusory tract.

Fig. 25. Same. Cross section slightly below middle of bulb.



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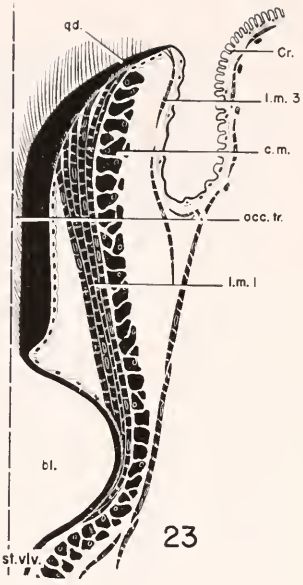

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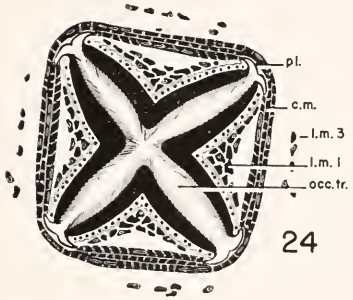

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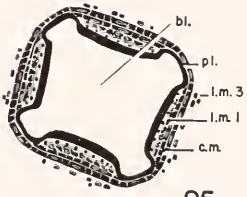

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PLATE 5

PLATE 6

Fig. 26. *Tapinoma sessile* (Say). Cuticular framework. (Worker; 0.12 mm.)

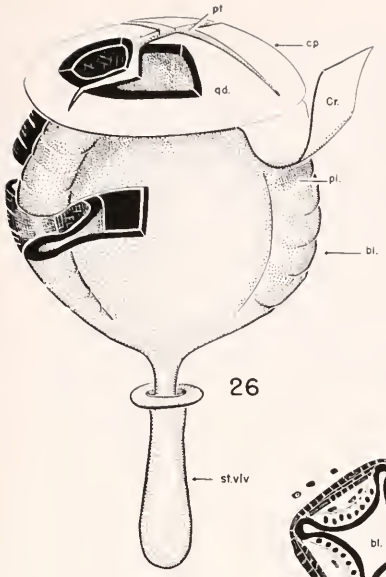
Fig. 27. Same. Longitudinal section through cupola and bulb.

Fig. 28. Same. Cross section through cupola near extremes of portal tips.

Fig. 29. Same. Cross section through middle of bulb.

Fig. 30. *Azteca* sp. Cuticular framework. (Worker; 0.18 mm.)

Fig. 31. Same. Longitudinal section through cupola, occlusory tract, and bulg (diagrammatic).



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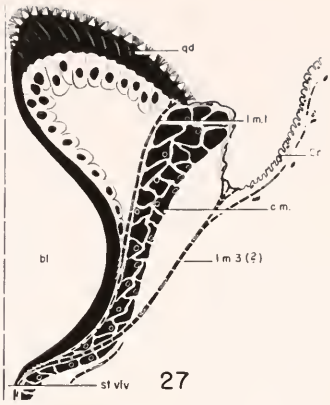

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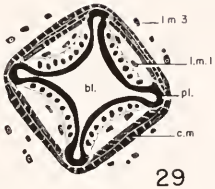

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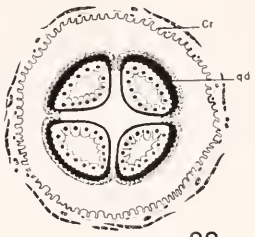

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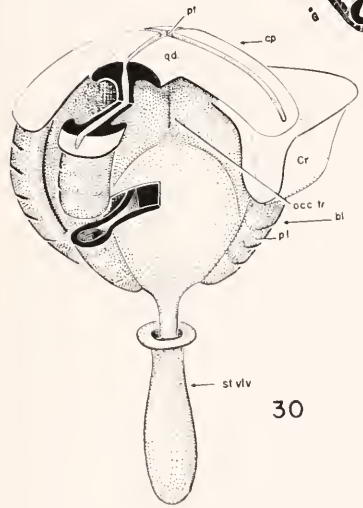

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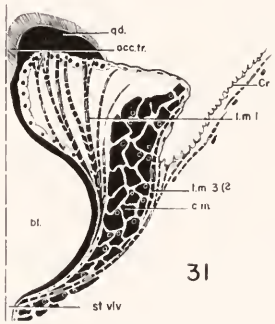

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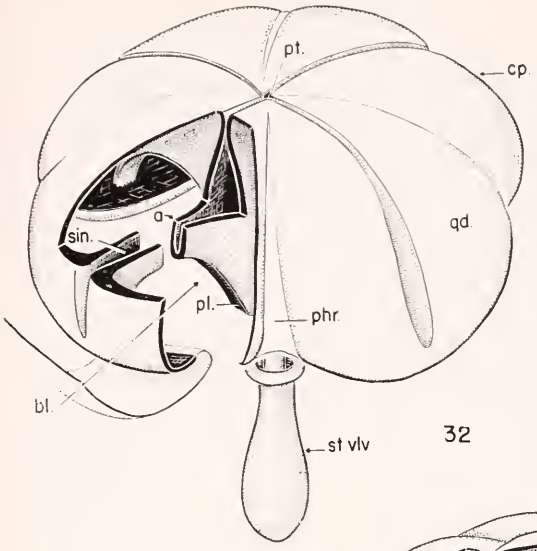
PLATE 6

PLATE 7

Fig. 32. *Iridomyrmex detectus* (F. Smith). Cuticular framework. (queen; 0.37 mm.)

Fig. 33. *Conomyrma thoracica* Santschi. Cuticular framework. (Worker; 0.12 mm.)



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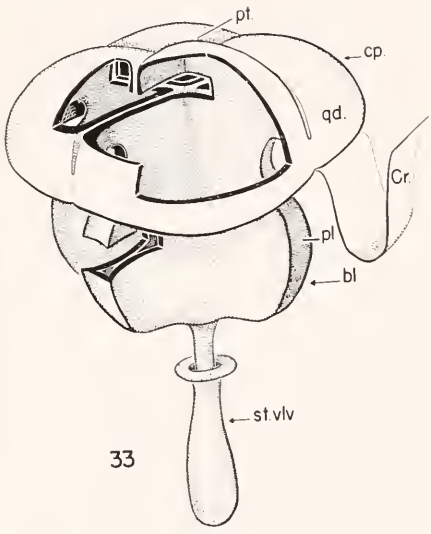

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PLATE 7

PLATE 8

Fig. 34. *Iridomyrmex detectus* (F. Smith). Longitudinal section through cupola and bulb.

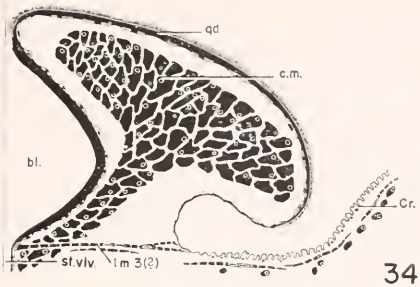
Fig. 35. Same. Cross section through widest portion of cupola.

Fig. 36. *Forelius foetidus* (Buckley). Longitudinal section through cupola and bulb.

Fig. 37. *Conomyrma thoracica* Santschi. Longitudinal section through cupola and bulb (diagrammatic).

Fig. 38. Same. Slightly oblique cross section through cupola.

Fig. 39. Same. Cross section through middle of bulb.



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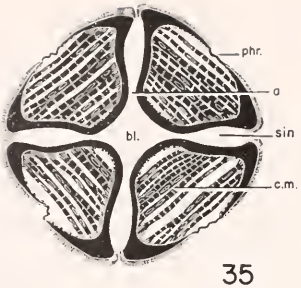

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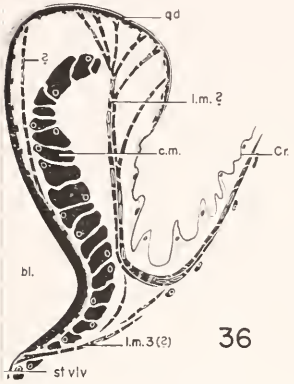

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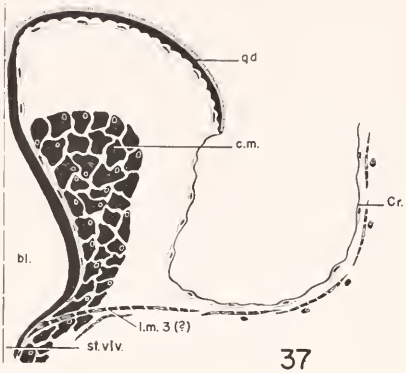

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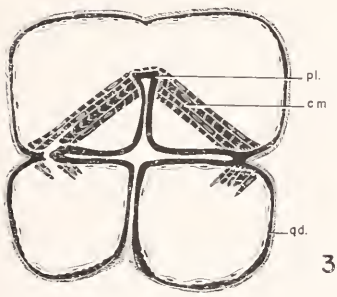

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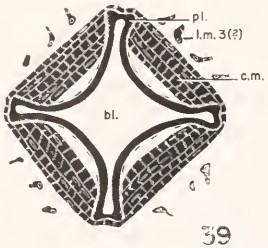

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PLATE 8

PLATE 9

Fig. 40. *Forelius foetidus* (Buckley). Outline of lateral view. (Worker; 0.10 mm.)

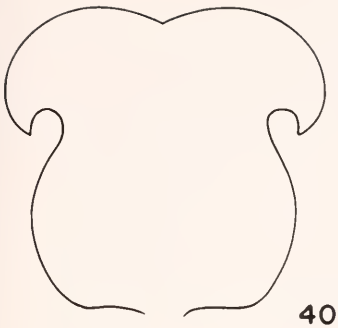
Fig. 41. Same. Frontal view.

Fig. 42. *Dorymyrmex ensifer* Forel. Outline of lateral view. (Worker; 0.12 mm.)

Fig. 43. Same. Frontal view.

Fig. 44. *Iridomyrmex viridiaeneus* Viehmeyer. Outline of lateral view. Worker; 0.13 mm.)

Fig. 45. Same. Frontal view.



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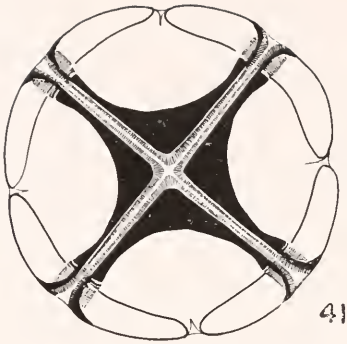

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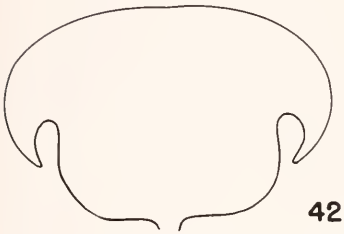

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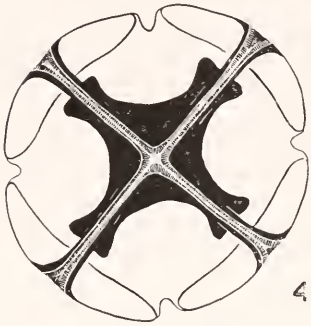

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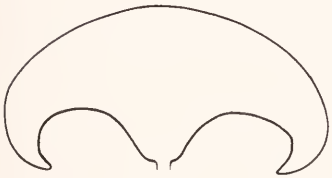

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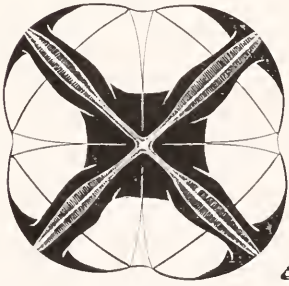

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PLATE 9

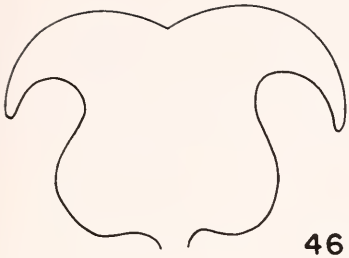
PLATE 10

Fig. 46. *Conomyrma thoracica* Santschi. Outline of lateral view. (Worker; 0.12 mm.)

Fig. 47. Same. Frontal view.

Fig. 48. *Technomyrmex detorquens* (Walker). Outline of lateral view. (Worker; 0.11 mm.)

Fig. 49. Same. Frontal view.



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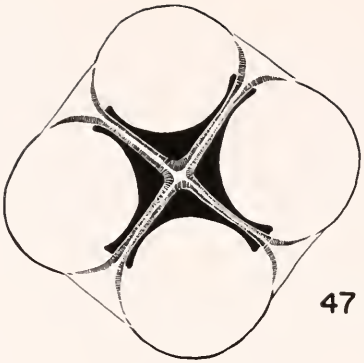

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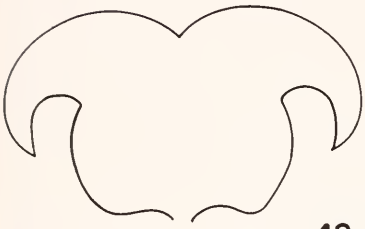

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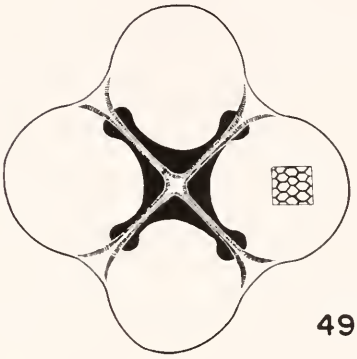

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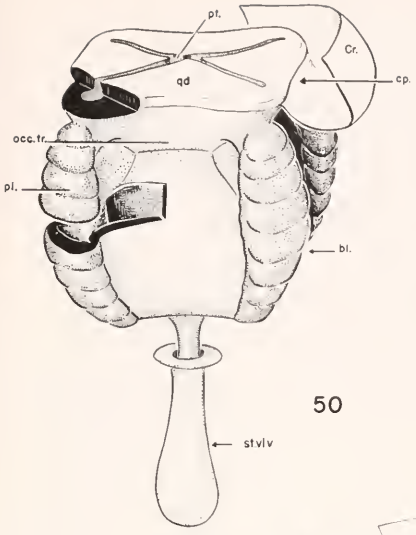
PLATE 10

PLATE 11

Fig. 50. *Notoncus ectatommoides* (Forel). Cuticular framework. (queen; 0.22 mm.)

Fig. 51. *Acropyga myops* Forel (or species near). Cuticular framework. (Worker; 0.23 mm.)

Fig. 52. *Melophorus bagoti* Lubbock. Cuticular framework. (queen; 0.55 mm.)



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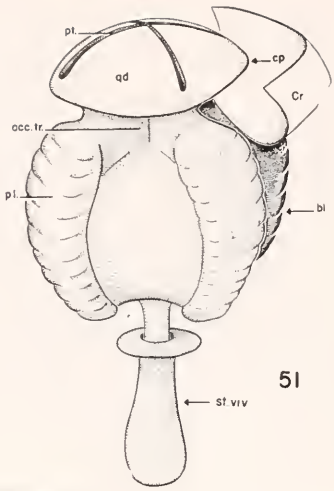

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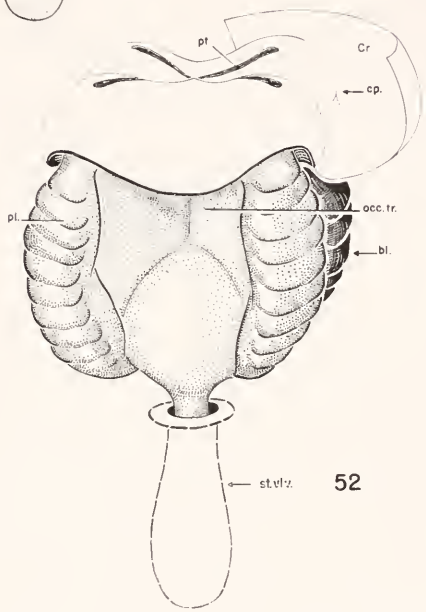

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PLATE 11

PLATE 12

Fig. 53. *Notoncus cetatommoides* (Forel). Longitudinal section through cupola, occlusory tract, and bulb.

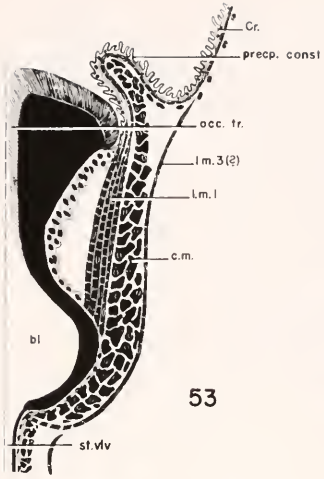
Fig. 54. Same. Proventriculus in relation to crop and midgut. (Note the *precupolar constriction* of the crop.)

Fig. 55. Same. Cross section through cupola.

Fig. 56. Same. Cross section through occlusory tract.

Fig. 57. Same. Cross section through anterior third of bulb.

Fig. 58. Same. Cross section through base of bulb.



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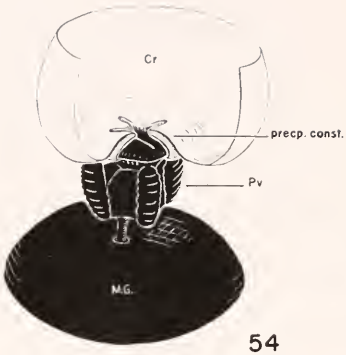

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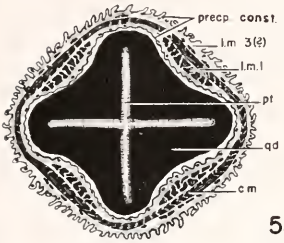

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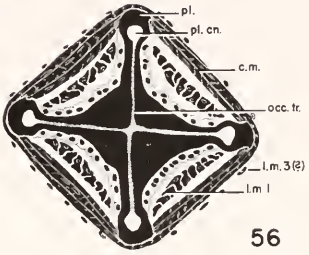

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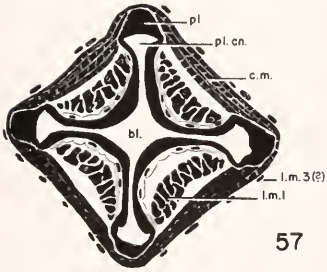

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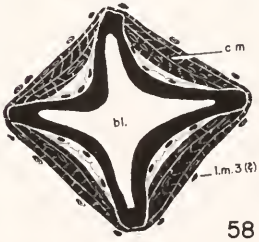


58

PLATE 12

PLATE 13

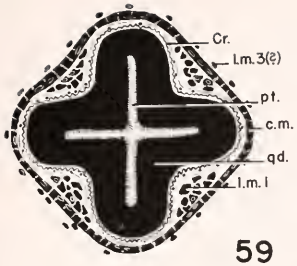
Fig. 59. *Melophorus* sp. (probably *ludius* Forel). Cross section through cupola.

Fig. 60. Same. Cross section through middle of occlusory tract.

Fig. 61. Same. Cross section through middle of bulb.

Fig. 62. *Aeropyga myops* Forel (or species near). Cross section through middle of cupola.

Fig. 63. Same. Cross section slightly above middle of bulb.



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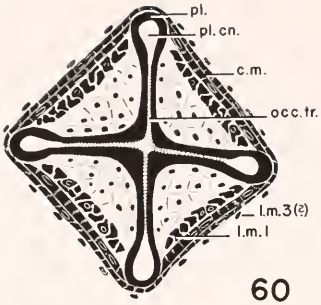

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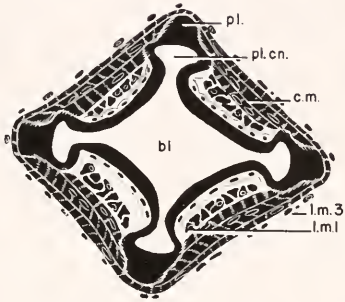

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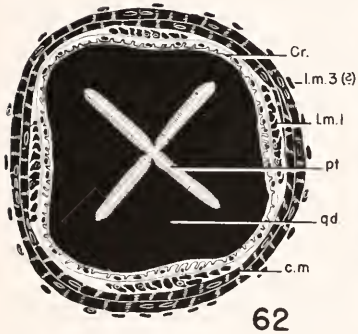

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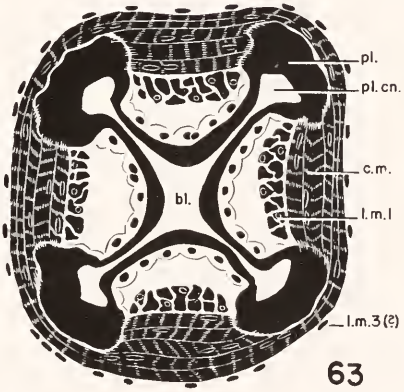


63

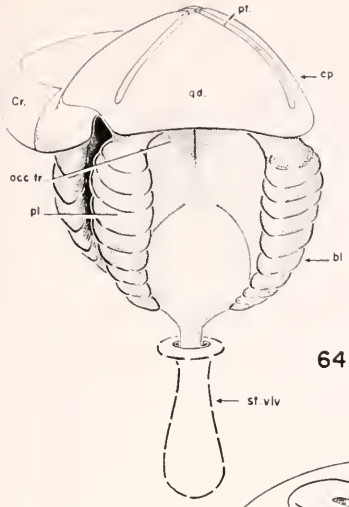
PLATE 13

PLATE 14

Fig. 64. *Anoplolepis custodiens* (F. Smith). Cuticular framework. (Worker; 0.35 mm.)

Fig. 65. *Acantholepis frauenfeldi* (Mayr). Cuticular framework. (Worker; 0.25 mm.)

Fig. 66. *Myrmoteras williamsi* Wheeler. Cuticular framework. (Worker; 0.11 mm.)



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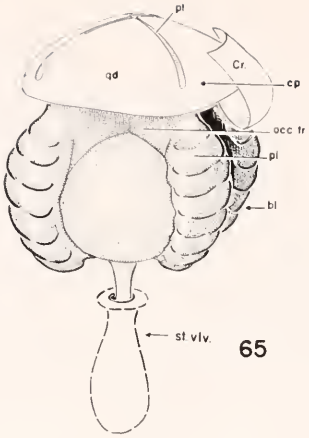

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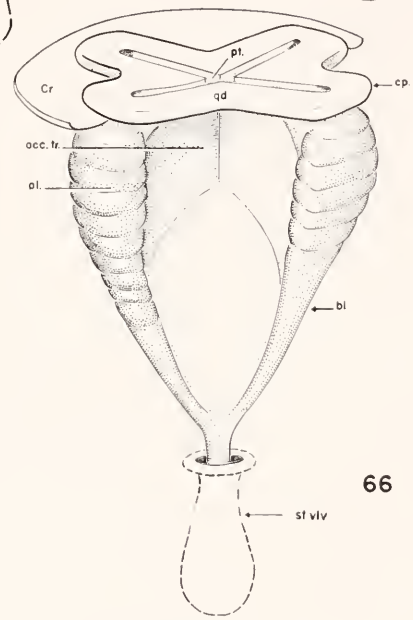
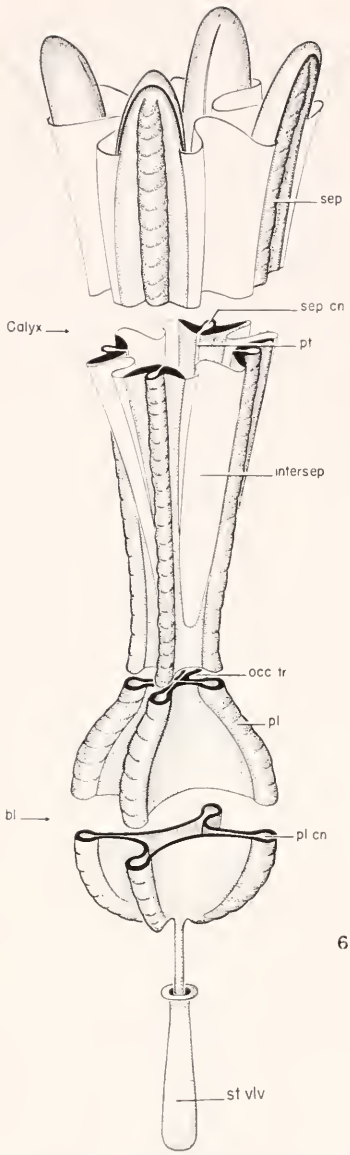


66

PLATE 14

PLATE 15

Fig. 67. Exploded diagram of the generalized sepalous formicine proventriculus (based on *Camponotus*).



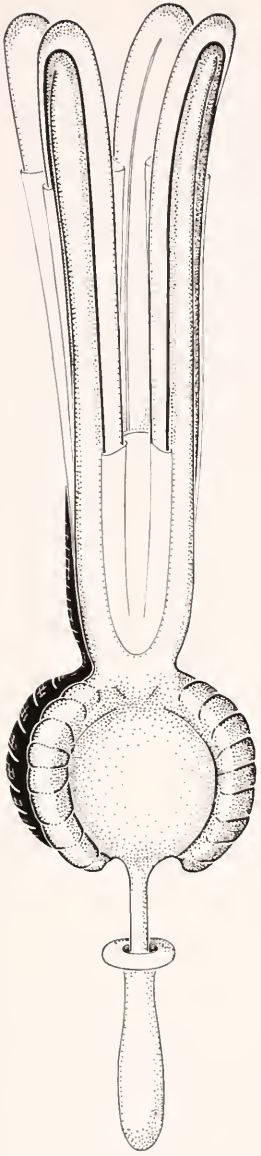
67

PLATE 15

PLATE 16

Fig. 68. *Camponotus vicinus* Mayr. Cuticular framework. (Major worker; 1.07 mm.)

Fig. 69. *Formica* sp. (*fusca* group). Cuticular framework. (Worker; 0.63 mm.)



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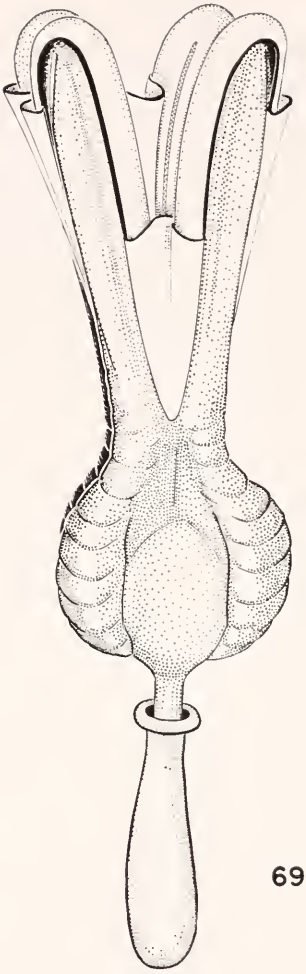


69

PLATE 16

PLATE 17

Fig. 70. *Camponotus americanus* Mayr. Longitudinal section through calyx (intersepalary cuticle) and bulb.

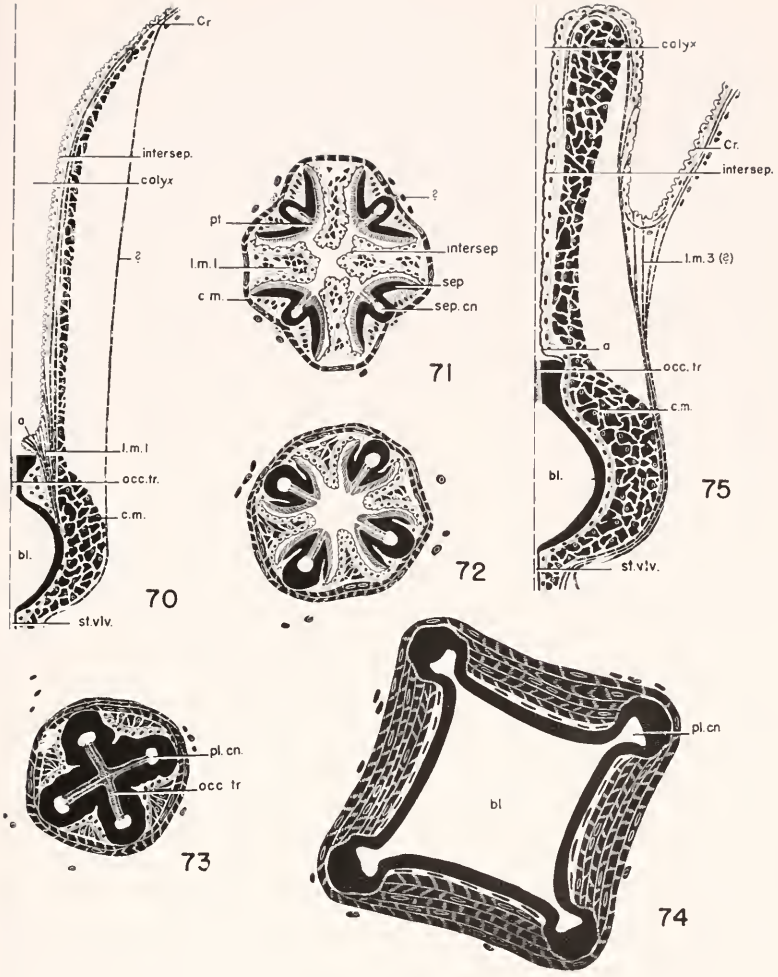
Fig. 71. *Camponotus vicinus* Mayr. Cross section through middle of calyx.

Fig. 72. Same. Cross section through base of calyx.

Fig. 73. Same. Cross section through occlusory tract.

Fig. 74. Same. Cross section through middle of bulb.

Fig. 75. *Formica* sp. (*fusca* group). Longitudinal section through calyx (intersepalary cuticle) and bulb.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c.m.
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71
72
colyx
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bl.
75
st.v.l.v.
pl.cn.
occ tr
73
pl.cn
bl
74

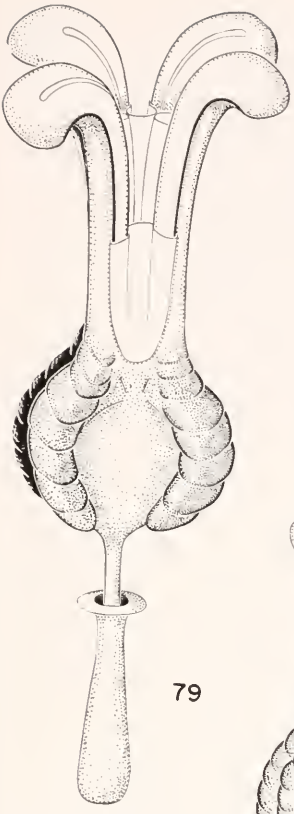
PLATE 17

PLATE 19

Fig. 79. *Myrmecocystus mexicanus* (Wesmael). Cuticular framework. (Worker; 0.53 mm.)

Fig. 80. *Gesomyrmex luzonensis* (Wheeler). Cuticular framework. (Worker; 0.30 mm.)

Fig. 81. *Paratrechina longicornis* (Latreille). Cuticular framework. (Worker; 0.17 mm.)



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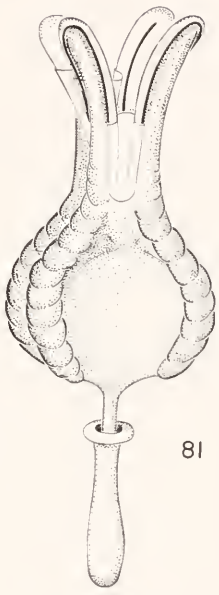


81

80

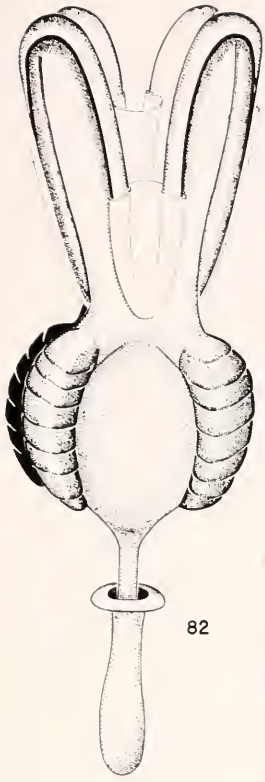
PLATE 19

PLATE 20

Fig. 82. *Cataglyphis* sp. (near *bicolor* Fabricius). Cuticular framework. (Worker; 0.64 mm.)

Fig. 83. *Oecophylla smaragdina* (Fabricius). Cuticular framework. (Worker; 0.43 mm.)

Fig. 84. *Brachymyrmex obscurior* Forel. Cuticular framework. (Worker; 0.30 mm.)



82

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84

PLATE 20

PLATE 21

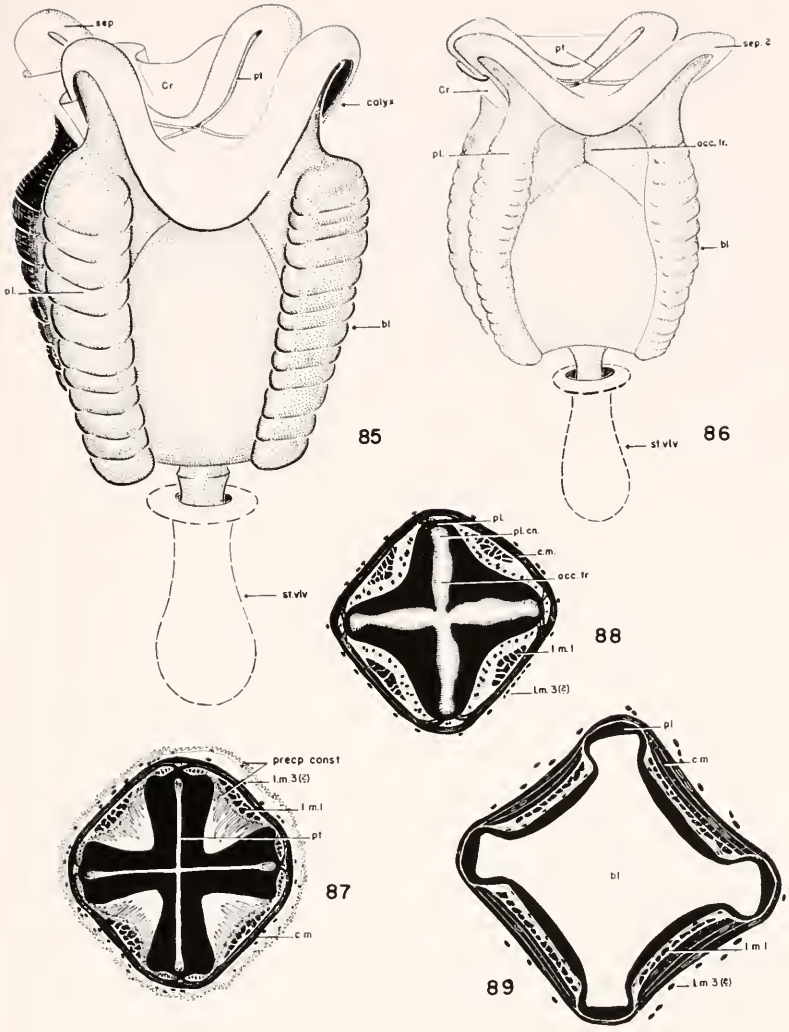
Fig. 85. *Cladomyrma hewitti* Wheeler. Cuticular framework. (Queen; 0.37 mm.)

Fig. 86. *Myrmecorhynchus emeryi* André. Cuticular framework. (Worker; 0.15 mm.)

Fig. 87. Same. Cross section through middle of bulb.

Fig. 88. Same. Cross section through occlusory tract.

Fig. 89. Same. Cross section through middle of bulb.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Cr
pl.
occ. fr.
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st.vlv
86
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c.m.
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88
precp const
l.m.3(ℓ)
l.m.1
pl
c.m
87
pl
c m
bl
l m 1
l.m.3(ℓ)
89

PLATE 21

PLATE 22

Fig. 90. *Odontomachus haematoda* (Linnaeus) or near. Cuticular framework (diagrammatic). (Worker; 0.25 mm.)

Fig. 91. *Amblyopone australis* Erichson. Cuticular framework (diagrammatic). (Worker; 0.20 mm.)

Fig. 92. *Phyracaces dumbletoni* Wilson. Cuticular framework (diagrammatic). (Worker; 0.15 mm.)

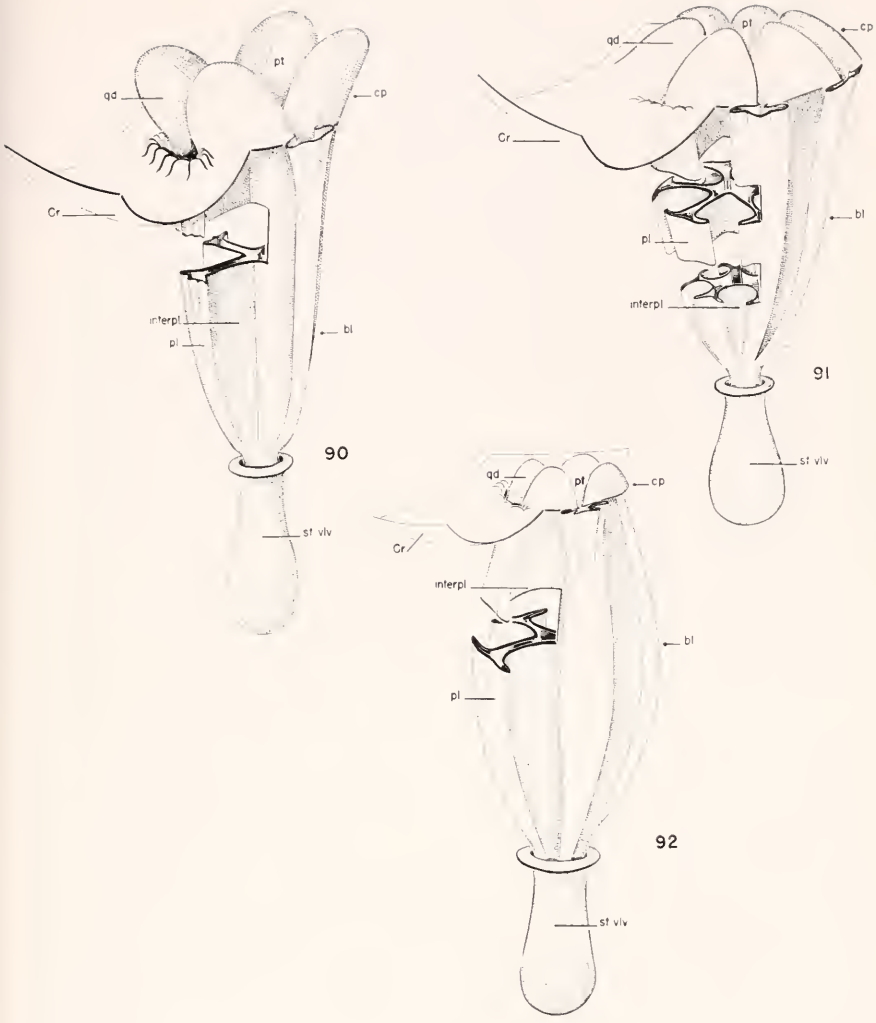

PLATE 22

PLATE 24

Fig. 97. Dendrogram showing evolution of the formicid proventriculus.

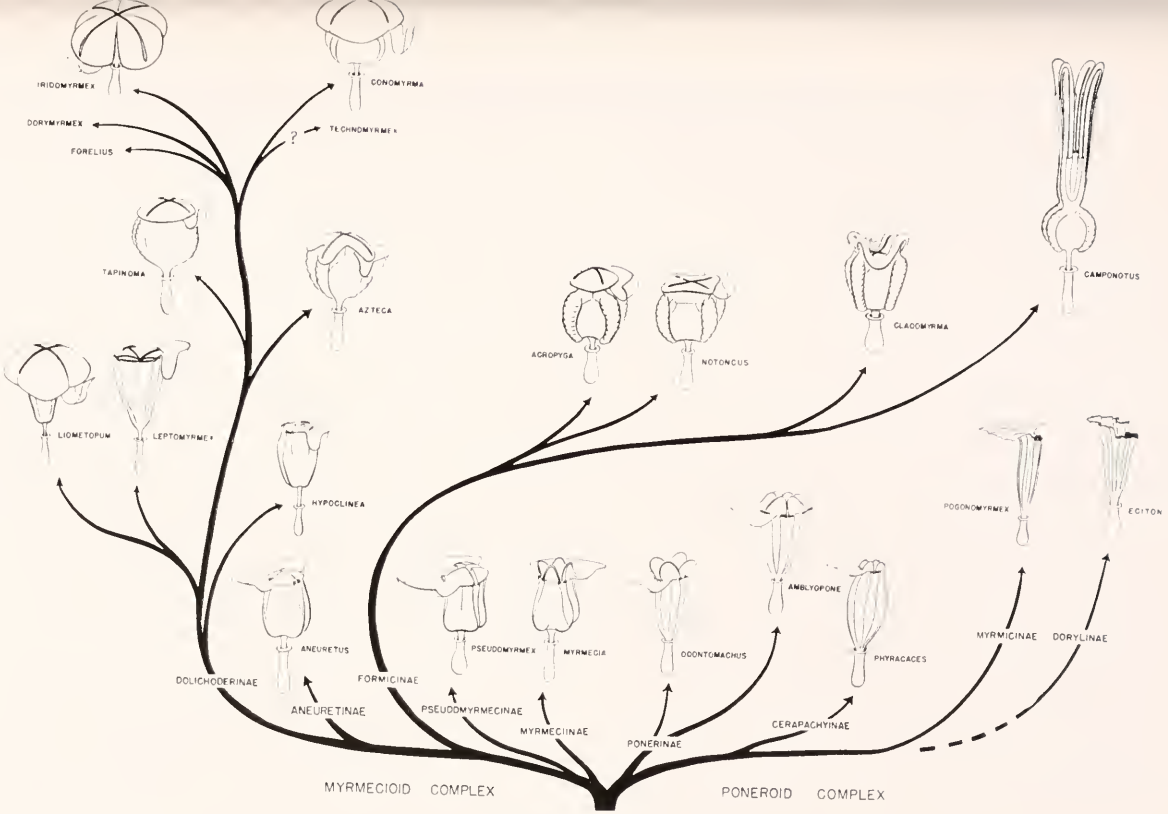
IRIDOMYRMEX
CONOMYRMA
DORYMYRMEX
TECHNOMYRMEX
?
FORELIUS
TAPINOMA
AZTECA
CAMPONOTUS
AGROPYGA
NOTONCUS
GLADOMYRMA
LIOMETOPUM
LEPTOMYRMEX
HYPOCLINEA
POGONOMYRMEX
ECITON
ANEURETUS
PSEUDOMYRMEX
MYRMECIA
ODONTOMACHUS
AMBLYOPONE
PHYRACACES
MYRMICINAE
DORYLINAE
DOLICHODERINAE
FORMICINAE
ANEURETINAE
PSEUDOMYRMECINAE
MYRMECIINAE
PONERINAE
CERAPACHYINAE
MYRMECIOID COMPLEX
PONEROID COMPLEX

PLATE 24

PLATE 25

Fig. 98. *Iridomyrmex detectus* (F. Smith). Longitudinal section through proventriculus. Note (arrow) the more or less compact layer of filtrate overlaying the cupola.

Fig. 99. *Leptomyrmex pallens* Emery. Longitudinal section through proventriculus. Note (arrow) the loose aggregate of filtrate among the cupolar hairs.

Fig. 100. *Formica* sp. (*fusca* group). Cross section through anterior third of calyx.

Fig. 101. Same. Cross section through base of calyx.

Fig. 102. Same. Cross section through occlusory tract.

Fig. 103. Same. Cross section through middle of bulb.

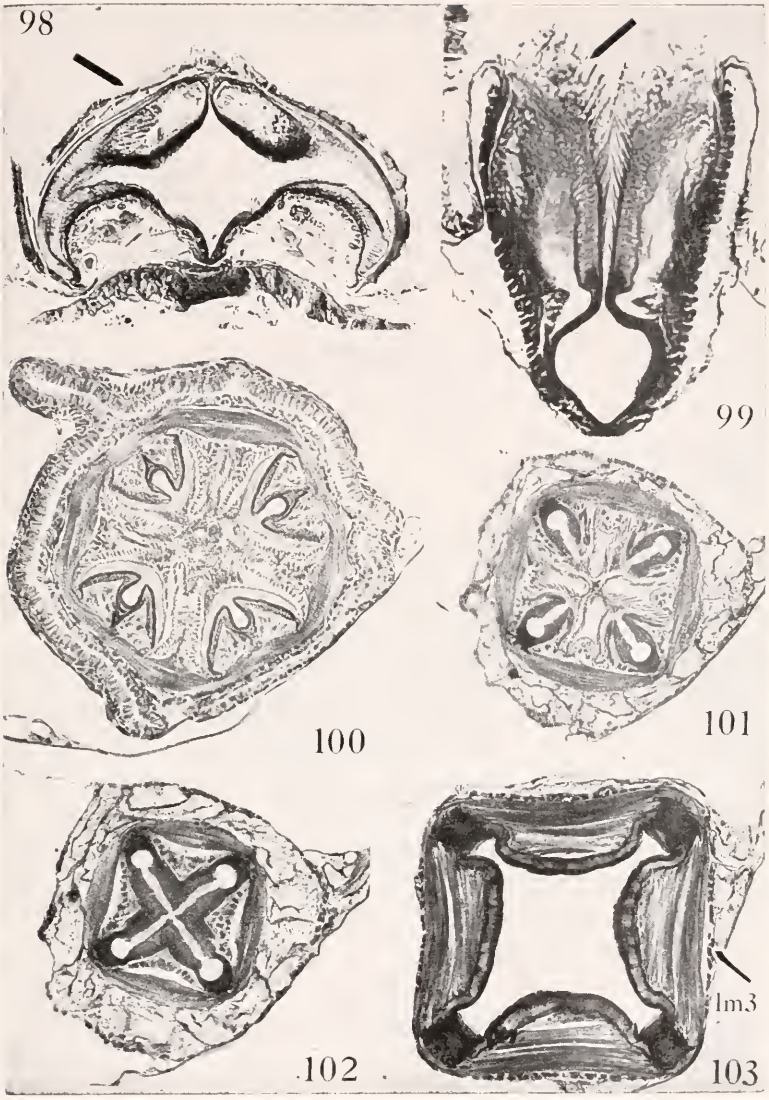

PLATE 25

Bulletin of the Museum of Comparative Zoology

AT HARVARD COLLEGE

Vol. 116, No. 9

THE *IXODES RASUS* GROUP OF AFRICAN TICKS WITH DESCRIPTIONS OF FOUR NEW SPECIES (IXODOIDEA, IXODIDAE)

By Don. R. Arthur

Department of Zoology, King's College, London,
and Consultant, Department of Medical Zoology,
U. S. Naval Medical Research Unit No. 3,
Cairo, Egypt

In Collaboration with

Colin Burrow

Harold Row Student, King's College, London

CAMBRIDGE, MASS., U.S.A.

PRINTED FOR THE MUSEUM

July, 1957

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AT HARVARD COLLEGE

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Memoirs (quarto) 1864–1938 — Publication was terminated with Vol. 55.

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PRINTED FOR THE MUSEUM

July, 1957

No. 9 — *The* Ixodes rasus *Group of African Ticks with Descriptions of Four New Species (Ixodoidea, Ixodidae)*

By Don R. Arthur[1] and Colin Burrow

INTRODUCTION

Hitherto the African ticks of the genus *Ixodes* which possess closed circular anal grooves have been incompletely investigated and all such ticks have been referred to the species *Ixodes rasus* Neumann 1899. This approach to the diagnoses of these ticks was established by Nuttall, Warburton, Cooper and Robinson (1911) and used indiscriminately until Schulze (1943) subdivided *rasus* into three subspecies (see later). Consequently, at the present time the status of *rasus* and other forms as yet undescribed presents an interesting problem to the systematist. This uncertainty of structure, coupled with our ignorance of the biology of the *rasus* group, opens up a particularly interesting and virgin field for research, and not a few unknown allied species undoubtedly await discovery.

Nuttall (1911) classified *I. rasus* in the biological group within the genus *Ixodes* in which males and females coexist together on a host that either wanders or does not travel far and in the subgroup where the sexes are found *in copula* on the host. Even so, the published reports show that the host range of the adults of the *I. rasus* group varies from small insectivores (mice, elephant shrews) to leopards, large antelopes, domestic dogs and man. The picture for immature stage-host relationships is more uncertain.

Specimens on which this report is based were obtained from Dr. H. Hoogstraal, NAMRU-3, Cairo, Egypt; Dr. Gertrud Theiler, Onderstepoort Veterinary Research Department; The Museum of Comparative Zoology (through the courtesy of Dr. J. Bequaert); Musée Royal du Congo Belge (through the courtesy of Dr. E. Dartevelle); Dr. Pierre Morel, Laboratoire Fédéral de l'Élevage George Curasson, Dakar, Senegal; Rocky Mountain

[1] The opinions and statements contained herein are the private ones of the Writers and are not to be construed as official or reflecting the views of the Navy Department or the Naval Service at large.

Laboratory, Montana (through the courtesy of Mr. Glen M. Kohls); Dr. J. Mouchet, Direction des Services de Santé Publique, Yaoundé, Cameroun Français; British Museum (Natural History) through the courtesy of Dr. G. Owen Evans and Mr. E. Browning; Mr. W. Grey, Mazabuka, Northern Rhodesia; Dr. Brazzard, Laboratoire d'Histoire Naturelle, École Nationale Vétérinaire, Toulouse, France.

This work was initiated when the writer (D.R.A.) was in receipt of a Leverhulme Research Award and completed on a visit to East Africa under a Colonial Welfare and Development Grant made available by the Colonial Office. This author wishes to record his thanks to these organizations as well as to members of the East African Veterinary Research Organization (particularly to Miss Jane Walker) for their hospitality, and to U. S. Naval Medical Research Unit No. 3, Cairo, Egypt for their great assistance and many kindnesses.

The following abbreviations are used to denote the sources of the material examined: BM, British Museum (Natural History); CNHM, Chicago Natural History Museum; EAVRO, East African Veterinary Research Organization; GHFN, Nuttall Collection, British Museum (Natural History); HH, Harry Hoogstraal, Cairo; JM, J. Mouchet, Cameroons; MC, Musée Royal du Congo Belge, Tervuren (Belgique); MCZ, Museum of Comparative Zoology; OP, Onderstepoort Research Station; RML, Rocky Mountain Laboratory Collection.

SYSTEMATIC DESCRIPTIONS

Ixodes rasus Neumann 1899
(Figures 1-13)

Ixodes rasus Neumann (1899), pp. 137-39, Figs. 12-14, described from 3 females and 1 male (cf. *Remarks* below) from Belgian Congo (cf. Bequaert, 1931, who refers type locality to French Equatorial Africa). Nuttall, Warburton, Cooper and Robinson (1911) repeat Neumann's description of the male, and describe another species of female (see under *Ixodes pseudorasus*). Schulze (1943) subdivided *rasus* into three subspecies, viz: *I. rasus rasus, I rasus cumulatimpunctatus* and *I. rasus eidmanni.* (Cf. *Remarks* below.)

Type material. Originally described by Neumann (1899, pp. 137-39) from three females and a copulating male, from *Hyrax* species collected in "the Congo" in A. Mocquerys coll. 1899. The present labelling of these specimens reads "740. *Ixodes rasus,* 1 male, 2 females (-1 female) *Hyrax* species, A. Mocquerys coll. 1899. G. Neumann det." An anomalous situation occurs here as Neumann stated that there were three females, whilst the present information states "2-1 females," and accordingly I propose that the remaining female specimen becomes the electotype. Electotype female, and allotype male deposited in the Neumann collection, No. 740, at the École Nationale Vétérinaire, Toulouse, France.

Paratype: 1 female, *Viverra civetta,* Congo Belge. Deposited at the École Nationale Vétérinaire, Toulouse, France, No. 761.

MATERIAL EXAMINED. Total 43 females; 6 males. 1 female (no host data) Dakar, Senegal: 1 female, wild pig, Cameroons, Fr. Berlin Zoo Museum, Dr. Schafer (GHFN—3005): 1 female, *Felis pardus* L., primary forest, Mainyu Bridge, Mamfe, Cameroons 500 ft. alt., 12.5.33. P. Sladen Trust Expedition (BM): 2 females, *Manis tricuspis* (=*Phataginus tricuspis* (Rafinesque)) secondary forest, Bashamii, Mamfe, Cameroons 23.3.33. I. T. Sanderson *leg.* (BM): 3 females (originally, 6 females according to legend in vial), *Cephalophus leucogaster* Gray, Efeileu, Bulu Country, Cameroons. 28.6.33. I. Sanderson *leg.* (BM): 6 females, 1 nymph, 8(5)1 N, White mongoose (783 M) Old secondary forest, Bashan. Mamfe Division Cameroons 28.6.1933, P. Sladen Trust Expedition, I. T. Sanderson *leg.* (BM): 3 females, *Nandinia binotata,* [probably *binotata binotata* (Reinwardt)] high deciduous forest, Mamfe, Cameroons, 30.4.1933. I. T. Sanderson *leg.* (BM): 2 females, "Schuppentier" (probably *Phataginus*), Lolodorf, Africa, 29.3.1907 (GHFN coll: no number): 1 female, 2 males, *Genetta tigrina* (subspecies not stated), Mongbivalu, 8/1939, Mme. Lepersonne *leg.* (MC 4502/4506): 4 females (no host data), Simba, (MC 8259 and 8262): 1 male (no host data) Flandrina, 6.3.1928. R. P. Hubsbaert *leg.* (MC no other information): 1 female, *Cercocebus albigena,* Okongena (Lububu), 22.9.1929, A. Collart *leg.* (MC 42096), nymphs ?, antelope, Masua, Lububu, 9.9.1929, A. Collart *leg.* (MC 43372/43386): 1 female, *Aulacodus* (=*Thryonomys* Fitzinger) *swinderianus* Temminck 1827, Aruwimi, Panga, -8.1925, J. Schouteden *leg.*

(MC 8220 and 8222): 1 female, *Sus* ? Leverville, 1927 (no other data) (MC 46569): 1 female, *Colobus badius badius* (Kerr), N'Dzida, Ivory Coast, 20.9.53. A. Villiers *leg.* (MCZ: 1 female, *Neotragus pygmaeus*, Yapo, Ivory Coast, A. Villiers *leg.* (MCZ): 1 male from Mongoose, Mt. Du Chaillu, Mt. Bijou, French Equatorial Africa, 8.8.1951. H. A. Beatty *leg.* (CNHM 73796) 2 females (no other data), OP coll. 2906: 2 females and 1 male "man and dog," Kumasi, Ashanti (GHFN 928)—this collection is a bulk sample of 9 females and 1 male, i.e. we have no knowledge of which specimens came from man or dog but the two *rasus* forms are readily distinguishable from the 7 female *pseudorasus* forms which are discussed later, with no intermediates: 3 females, "Pangolin or Scaly manis, Mubango, Mabina Forest, Kyagle, Uganda, 4000 ft. Capt. C. R. S. Pitman *leg.* (BM 6.19. 1-20): 1 female, *Lophuromys aquilus aquilus* (True), Nyika Plateau, Nyasaland, 9.10.1948. A. Loveridge *leg.* (MCZ): 1 female, *Manis tricuspis* (=*Phataginus tricuspis* (Rafinesque)), Fernando Po. (BM).

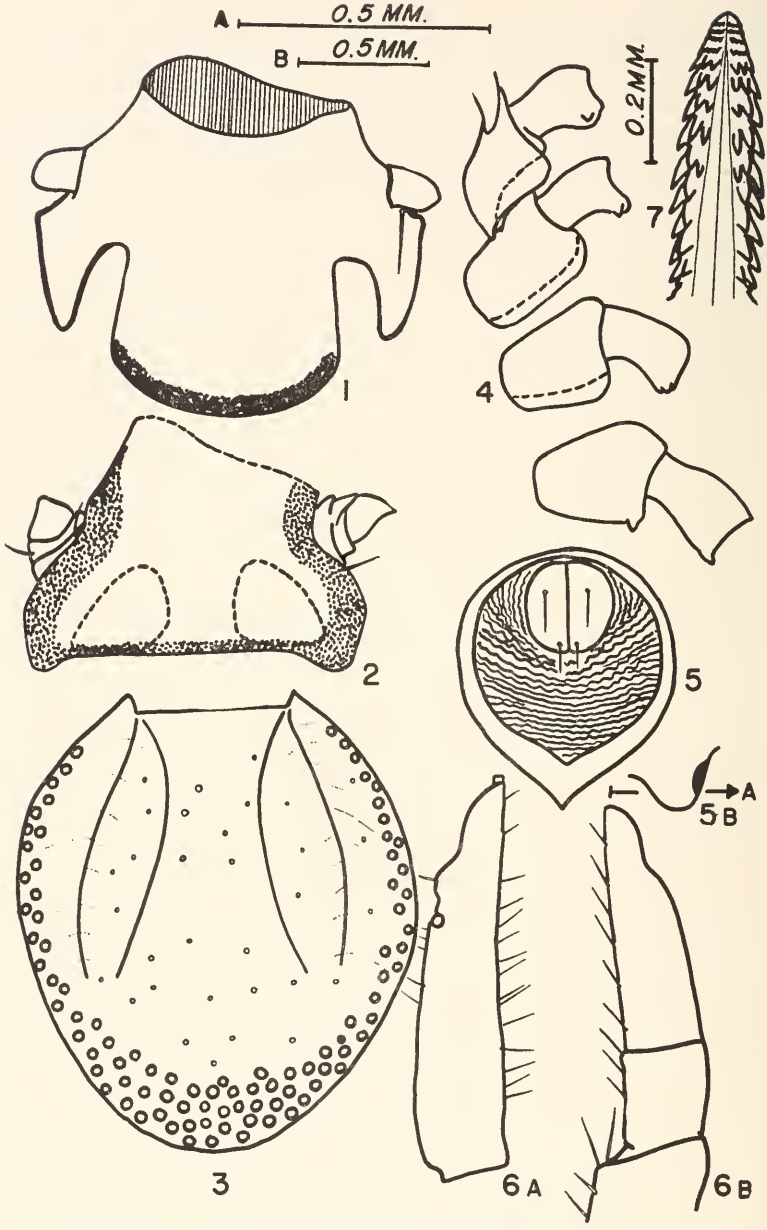
Distribution. From the records we have examined, *Ixodes rasus* is to be found in many parts of West and Central Africa and is common locally in East Africa. WEST AFRICA. Senegal, Ivory Coast, Gold Coast; CENTRAL AFRICA. Fernando Po, Cameroons, French Equatorial Africa (Bequaert 1931 refers the type locality to French Equatorial Africa, not to the Belgian Congo), Belgian Congo; EAST AFRICA. Uganda, Nyasaland, Northern Rhodesia, Sudan. Previous records of *I. rasus* from Southern Rhodesia (Nuttall 1916) refer to *I. pseudorasus* and those of Cooley in the Rocky Mountain Laboratory, Montana to *Ixodes pilosus*. The material of the records of Bedford 1929 and 1932 are not available for re-examination.

Hosts. The wide range of hosts for the adults previously given for *I. rasus* has now become considerably reduced (cf. Hoogstraal, 1956). The immature stage-host relationships must remain in abeyance until such time as the larvae and nymphs are bred and their diagnostic characters ascertained. The present known hosts of the adults are: "wild pig," *Felis pardus, Phataginus tricuspis, Cephalophus leucogaster,* white mongoose, *Nandinia binotata, Genetta tigrina, Cercocebus albigena,* antelope, *Aulacodus* (= *Thryonomys*) *swinderianus, Colobus badius*

badius, Neotragus pygmaeus, dog, man, *Lophuromys aquilus aquilus, Hyrax* (type specimen), *Viverra civetta.*

Biology. Unstudied.

Remarks. The Neumann collection at the École Vétérinaire, Toulouse, contains in addition to the electotype and the paratype two lots of specimens identified by Neumann as *I. rasus* and bearing the following data: (1) "Ousambara (Afr: or Allem:) det. by G. Neumann 1900, 1 female," and (2) "*I. rasus* Nn. Bismarckburg (Togo). Conradt *leg.* G. Neumann det. 1899. Berlin Mus." 1 female. The first specimen is *I. pseudorasus,* the second *I. oldi* Nuttall 1913. Schulze (1943) indicated that circular anal grooves are characteristic of this species and in some instances they may be drawn out or narrowed posteriorly. This is in fact true for the electotype (see description). To what extent Schulze (1943) was justified in dividing *rasus* into three subspecies is problematical. Schulze's *I. rasus rasus* undoubtedly refers to Neumann's *rasus* and he adds little to Neumann's description of the male beyond directing attention to the lobes on the ventral side of the basis capituli and the correction of the position of the genital orifice. Similarly he gives the same characters for *I. rasus eidmanni* stating that they are "more strongly chitinized (!) and darker," the denticles of the hypostome with a small apical hook (true also for *I. rasus*), proximity of sensory organs in the integument and absence of a definite "peripheral zone" of the integument. These distinctions would appear to me to be of doubtful value in establishing a subspecies, particularly as the numbers examined were inadequate. This subspecies has been collected at Rio Muni and Spanish Guinea. I have no specimens of *I. rasus* from either source and the only specimens from Rio Muni constitute a distinct new species (*Ixodes muniensis*) which is described later. I have failed to see the original material of *I. cumulatimpunctatus* and have seen nothing in the extensive African tick fauna investigated that is comparable with it. The occurrence of the "sichelhaar" in the capsule of Haller's organ in *I. rasus* (see Schulze 1943) is applicable to a large number of *Ixodes* ticks, and the break in the chitin within the depression (trough), to which Schulze alludes, is due to a failure to appreciate that the cuticle


A
0.5 MM.
B
0.5MM.
0.2MM.
1
2
3
4
5
5B
A
6A
6B
7

in this region is saddle shaped in the majority (if not all) *Ixodes* ticks (Arthur, 1956).

Redescription of the electotype FEMALE. Body well engorged, dried specimen, dark red color, sclerotized parts dark red brown.

Capitulum (Figures 1, 2). Length of *basis capituli* to hypostomal base, 0.43 mm., breadth of basis across dorsal ridge, 0.62 mm., sub-triangular, straight lateral margins slightly divergent to palpal base, postero-lateral margin produced into cornua which are broader basally than long, rounded apically; well-defined posterior margin, straight and salient, black pigmentation peripherally (Figure 2). Surface gently convex with reticulate sculpturing, lateral surface slightly curved. *Porose areas* strongly depressed, sub-triangular in outline separated by a distance equivalent to their greatest breadth. *Basis capituli* broad ventrally; auriculae as large strong blunt retrograde processes, anterior angle sharp, posteroventrally directed and stand well out from the periphery of the basis. Distal part of capitulum in electotype broken off. *Hypostome* (Figure 7) 0.56 mm. in length, tapering apically, profile curved; dentition from base to apex, 1 row of 1/1; 4 rows of 2/2, 5 rows of 3/3, 4 rows of 3/3, slight corona present, denticles long, hook-like. (Hypostomal structure determined from females collected in Simba, MC 8259 and 8262.)

Scutum. Broadly ovate (Figure 3) but widest in front of mid-length, tapering more strongly to rounded posterior margin; colour, dark red-brown, surface reticulate. *Cervical grooves* as wide depressions most pronounced about mid-way along; cervical field flat, surface is strongly elevated lateral to these grooves but without indication of lateral ridge; *punctations* large, deep and close together marginally, smaller and more widely separated elsewhere.

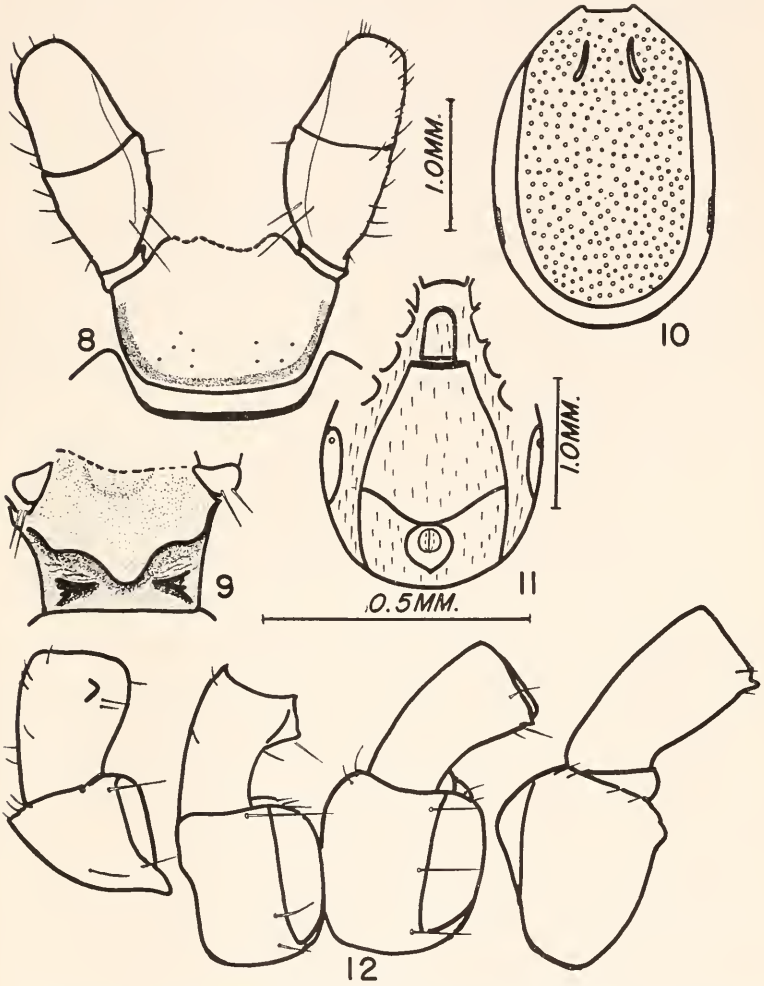
Figs. 1-7. *Ixodes rasus*, female: 1. Capitulum, ventral; 2. Capitulum, dorsal; 3. Scutum; 4. Coxae and trochanters I-IV; 5. Anal plate; 5B, diagram of anal plates in side view as drawn in Figure 5. Male: 6A. Tarsus I; 6B. Tarsus IV; 7. Hypostome of female. (Scale A refers to Figs. 1, 2, 4-7; scale B refers to Fig. 3.)

Legs. Moderately long and stout, distal segments missing from first three legs on right side, similarly on second leg on left side. *Coxae* slightly convex, reticulately patterned, coxae I, II and III syncoxae, coxa I with distinct short broad internal spur, coxa IV with external spur, short, broad; blunt tapering trochanter spurs on legs I to IV (Figure 4). *Tarsi* missing in electotype and paratype specimens. In specimens from Simba (MC 8259 and 8262), long, tapering with slight hump in front of Haller's organ on tarsus I; similar humps on succeeding tarsi; length of tarsus I, 0.85 mm., metatarsus I, 0.45 mm.; tarsus IV, 0.71 mm., metatarsus IV, 0.54 mm. (Figures 13A, B). *Genital opening,* level with the third coxal interspace, genital apron bilobed. *Anal opening* located far back on the body, convex anal valves with two pairs of fine long hairs, anal grooves circular, closed, and *drawn out into a point* in the electotype specimen (circular in paratypes and other specimens examined); in Figure 5 the region bounded by groove is deeply sunk in front so that the anal valves are almost vertical; this sinking is less pronounced posteriorly. *Spiracular plate* transversely oval, macula central, goblets small, numerous. Body hairs fine, short, sparse.

Redescription. MALE. Elongate oval body, narrowing slightly anteriorly, posterior extremity broadly rounded, length excluding basis, 2.56 mm., breadth 1.6 mm. Legs, scutum, dark reddish brown.

Capitulum (Figures 8, 9). Greatest breadth of *basis capituli* posterior to palpal insertion, 0.43 mm., much broader than long, and converge by rectilinear and curved postero-lateral margins to a slightly convex, salient posterior border; surface flattened, brown in colour, bordered by darker band of pigmentation (stippled in Figure 8) which does not extend to the periphery, small scattered distinct pores. *Palpi* short, broad, length of article 2, 0.22 mm., article 3, 0.23 mm., greatest width of 0.19 mm. at junctions of articles 2 and 3; lateral margins almost straight, mesial profile of article 2 convex, that of article 3 straight, tapering to broadly rounded apex; pronounced flanging effect (''roll collar'') along meso-dorsal edge of article 2, continued for some distance along article 3; mesial surface of palp very slightly concave; *hairs* short to moderate in length, numerous, par-

ticularly on outer side, article 1 bears mesial spur. In ventral view *basis capituli* broad, traversed by undulating ridge; mesial lobe of which is more strongly convex than those on either side,



Figs. 8-12. *Ixodes rasus,* male: 8. Capitulum, dorsal; 9. Capitulum, ventral; 10. Dorsum; 11. Venter; 12. Coxae and trochanters I-IV.

steep slope from ridge to hypostomal base, behind ridge surface declivitous, broken by irregular ridges and particularly by two sharp triangular elevations (Figure 9). (The hypostome and chelicerae are missing, but Neumann (1899) gives the length of the former as 0.55 mm.)

Scutum (Figure 10). Length 2.33 mm., breadth 1.33 mm. Elongate, sides straight between the sharply angled antero-lateral border and the broad rounded extremity; surface convex, dark reddish-brown colour, marginal fold white, of uniform width, 0.175 mm. wide [Neumann (1899), repeated by Nuttall *et al.* (1911) states that body fold is narrow (0.1 mm.)]. Cervical grooves faint anteriorly, leading into short, moderately deep, wide depressions. *Punctations* of moderate size and depth, uniformly distributed, pronounced. *Ventral plates* (Figure 11): pregenital plate longer than broad, posterior and lateral borders straight, anterior margin rounded; median plate large, diverging quite strongly to junction with adanal plates: sides and posterior margin sinuous; adanal plates not joined behind anal plate, latter circular *but drawn out into a small but distinct point behind,* as in female; numerous punctations of similar form to those on scutum. Abundantly supplied with short hairs, which are shorter than those on the epimeral plates. *Anus* eccentric, nearer anterior rim of anal groove.

Legs. Long, last two segments of fourth pair of legs extend beyond posterior limits of body. *Coxae* (Figure 12). Large, shiny, dark reddish brown, slightly convex and somewhat rugose, such hairs as are present, long; coxae I to III syncoxae; *coxa* I short, tapering spur on posterointernal angle, external spur short and broad on *coxae* IV, *coxae* II and III unarmed; distinct tapering trochanter spurs on legs I to IV; *tarsi* (Figures 6A, B) much as in female; length of tarsus I, 0.79 mm.; tarsus IV, 0.65 mm.

Ixodes pseudorasus new species

(Figures 14-31j)

Ixodes rasus pro parte Nuttall, Warburton, Cooper and Robinson 1911, Pt. II, pp. 229-30, Figures 225-226. Described females from cattle in

Uganda (GHFN 877d), from leopard, Obuasi, S. Ashanti (GHFN 503) and from man and dog (GHFN 928) — this last record is discussed under host list of *I. rasus*. It would appear that these writers did not see the types of Neumann and state that their description differs from that of Neumann (1899) in respect of the female.

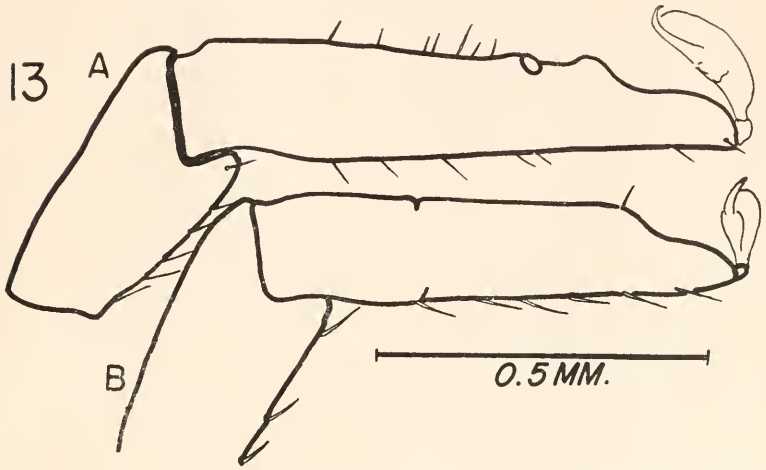
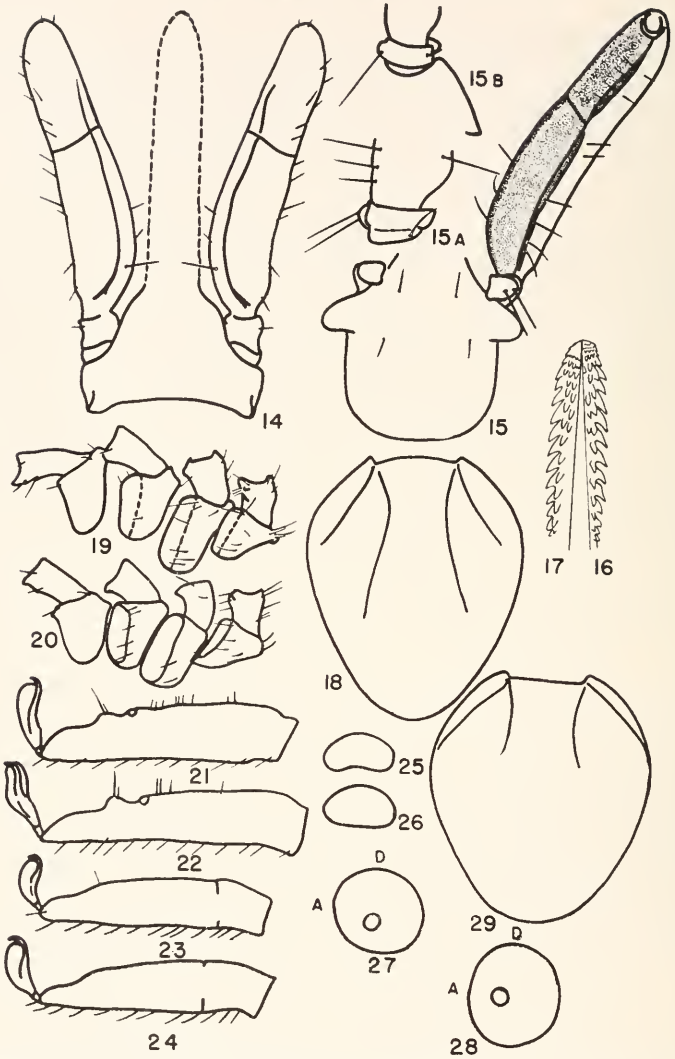


Fig. 13. *Ixodes rasus*, female: A, Tarsus and metatarsus I; B, Tarsus and metatarsus IV.

MATERIAL EXAMINED. Two females, goat, Beeba-Sharo, Belgian Congo, 23.V.1913, F. Harker *leg.* (GHFN 2353): 2 females, (no host cited) Ibembo, 6.7.50 (MC 70016): 4 females, dog, Port Franqui, -2.1934, Dr. Bouvier *leg.* (MC 38651); 1 female, *Okapia*, Epulu, 1933, R. Fr. Hutsebaut *leg.* (MC 46515/46518): 6 females, *Okapia*, Epulu, 1938, R. Fr. Hutsebaut *leg.* (MC 46674/46662); 3 females, *Okapia johnstoni*, Epulu River, Ituri District, Belgian Congo, P. Putnam *leg.* (BM): 2 females, *Potamochoerus porcus*, Ibembo, 6.7.1950, R. Fr. Hutsebaut *leg.* (MC): 1 female, *Procavia* ? Burunga, Kiru, -12.1925, Dr. Schouteden *leg.* (MC 8178 & 8182): 1 female, 3 nymphs, *Tragel-*



Figs. 14-29. *Ixodes pseudorasus* and variant form; 14-15 female of *I. pseudorasus*: 14. Capitulum, dorsal; 15. Capitulum ventral; 15A, B. Palpal article 1, dorsal and ventral; 16, 17. Hypostome, *I.pseudorasus* and variant form respectively; 18. Scutum (*I.pseudorasus*); 19, 20. Coxae and trochanters, *I.pseudorasus* and variant form respectively; 21. Tarsus I (*I. pseudorasus*); 22. Tarsus I (variant form); 23. Tarsus IV (*I.pseudorasus*); 24. Tarsus IV (variant form); 25. Genital apron (variant form); 26. Genital apron (*I.psevdorasus*); 27, 28. Spiracular plate, *I.pseudorasus* and variant form respectively; 29. Scutum (variant form). The letters *A,D,P,V* refer to anterior, dorsal, posterior and ventral directions, respectively.

aphus scriptus, Kibombo, Belgian Congo, (MCZ): 2 females, Buffel, Ibembo, 2.8.1950, R. Fr. Hutsebaut *leg.* (MC 67307): 1 female, cow, Costermansville, Vercommen 1950 (MC 61269): 2 females, *Potamochoerus porcus*, Ibembo, 6.7.1950, R. Fr. Hutsebant *leg.* (MC 70016): 2 males, 2 females, *Cricetomys gambianus*, Mt. Selinda, Southern Rhodesia -12.55 (OP 2433 ii): 3 females, man, Mt. Selinda, Sth. Rhodesia, 23.9.55 (OP 2433 v): 1 female, 5 nymphs, Chevrotain, north central Rio Muni, 23.4.1954, K. C. Brown *leg.* B.22832, gift of R. Traub, (HH): 1 nymph ? forest antelope, north central Rio Muni, 18.5.1941, gift of R. Traub, (HH): 4 females, leopard, Obuasi, Ashanti, -12.1908 (GHFN 503), 7 females, man or dog? -10.1907, Dr. Graham *leg.* (GHFN 928): 1 female, Gold Coast, no other data (Entomol. Research Com. Cat. No. 762a. 14.4.1922. S. BM): 2 females, *Cricetomys gambianus*, Bibianaha, Gold Coast, 3.12.1911. N. C. Rothschild *leg.* (BM): 6 females, Sierra Leone (no other data. BM): 1 female, *Cephalophus*, Tanga, German East Africa (BM); 2 females, Umboyasi River, Mgongo, British East Africa, no other data (BM): 1 female, cattle, which came from Bukedi to Mpumu, Uganda; 10.9.1909, D. Bruce *leg.* (GHFN 877d): 1 female, 10 nymphs, Bushbuck, Kyagwe, Uganda, N. W. Mettam *leg.* (GHFN 3829a): 1 female, giant rat, Mubango, Mambina Forest, Kyagle, Uganda 4000 ft. alt., 1932, Capt. C. R. S. Pitman *leg.* (BM 6.19. 21): 3 females, *Centropus* (?) *superciliosus* Loande, Kampala, Uganda, -9.39. (BM): 1 female, several nymphs, Pygmy Antelope, *Neotragus moschatus akeleyi*, Mt. Kenya, 7000′, Kenya: 9 females, cattle, Kitale, A. Wiley *leg.* 5.4.49 (EAVRO): 19 females, *Boocercus eurycerus*, Kabolet Forest, near Kapenguria, 23.2.56, S. F. Barnett *leg.* (EAVRO): 3 females, *Cricetomys*, Mlange, Nyasaland -.10.1914 (BM 13.12.30. 29-30): 3 females, *Mungos melanurus*, Zomboe, Nyasaland 1915 (BM 1915. 12. 30, 3/-33): 1 female, 1 male "tick bird" stomach ? Tanganyika, (Vet. Lab., Kabete): 1 female, Dakar, Senegal (No other data).

Distribution. The general pattern of the distribution of this species follows closely that of *I. rasus*, except that as far as present valid records are concerned there are far more records from East Africa. WEST AFRICA. Senegal, Ivory Coast, Gold Coast. CENTRAL AFRICA. Rio Muni, Belgian Congo. EAST AFRICA. Uganda, Kenya (British East Africa), Tanganyika (German East Africa), Nyasaland, Southern Rhodesia.

Description. FEMALE. Body of unfed female short oval, broadest at about the posterior third.

Capitulum (Figures 14, 15). *Basis capituli* sub-triangular, posterior margin straight or slightly undulate, sides curved, surface convex, broad, rounded, very short broad cornua; *porose areas* pear-shaped, less frequently oval, separated by a distance less than their maximum diameter, when oval usually set obliquely to long axis of body. *Palpi* long, lateral profile slightly concave except for slight baso-lateral swelling, mesial profile of article 2 broadly curved, that of article 3 straight, apex rounded with inner angle acute, outer angle rounded, meso-dorsal margin of article 2 and proximal part of article 3 flanged, palpal hairs moderately long basally on article 2, shorter on article 3. Ventrally (Figure 15) *basis capituli* has straight lateral margins, with postero-lateral and posterior margins broadly rounded, two pairs of hairs in position indicated in Figure 15; surface either flat or gently convex; auriculae form broad flat lobes with rounded apices. Palpal article 1 (Figures 15A, B) drawn out into a mesodorsal flange and a ventro-lateral lobe supplied with a long hair; article 2 with few hairs of moderate length basally, hairs shorter and more abundant on article 3; inner face of article 2 flat, that of 3 slightly concave. Length of capitulum, 1.1 mm.; breadth of capitulum across dorsal ridge, 0.48 mm.; breadth of capitulum across auriculae, 0.57 mm.; length of palpal article 2, 0.47 mm.; greatest breadth of palpal article 3, 0.16 mm.; length of palpal article 3, 0.37 mm. *Hypostome* (Figure 16) long, gently curved profile lines, rounded at the tip, small "corona"; dentition, 2 rows of 4/4, 4 rows of 3/3, and 7 rows of 2/2 teeth.

Scutum (Figure 18). Length 1.42 mm., breadth 1.15 mm., widest in front of middle, curving strongly to scapular base, less strongly posteriorly, sides almost rectilinear and terminate in a rather narrowly curved posterior margin, scapulae short, pointed, emargination slight; *lateral carinae* slightly indicated, short, ceasing just beyond the greatest width; *cervical grooves* superficial, shallow, not reaching to postero-lateral border. *Punctations* consisting of closely set groups of small pores, uniformly distributed, short hairs.

Legs. Moderate length; *coxae* I, II and III syncoxae: coxa I sub-triangular with well developed areae coxales supplied with

stout hairs, other hairs fine, variable in length, internal spur lacking, the postero-internal extremity rounded, coxae II and III longer than broad, supplied with hairs of uniform length, coxa IV subtriangular, spurs absent; trochanters I–III with short, broad, blunt spurs. *Tarsi* long, tarsus I, 0.74 mm., tarsus IV, 0.67 mm. (Figures 21, 23) tapering fairly gradually to slight hump beyond Haller's organ, pad almost as long as claws.

Genital opening. Between coxae IV, covered with translucent unilobed genital apron (Figure 26) genital grooves horseshoe-shaped.

Anal grooves. Situated far back, rounded and drawn out posteriorly into a small point.

Spiracular plate (Figure 27). Round, macula almost antero-ventral in position.

Variants. The only consistent variant forms, which I have encountered are 9 females collected from "Vache, Costermansville, Vercommen 1950, MC coll. 69733."

Description. FEMALE. These specimens are dark brown and the alloscutum bears scattered short white hairs.

Capitulum (Figures 30, 31). Length 0.98 mm., breadth across *basis capituli* just behind insertion of palpal article 1, 0.54 mm.; surface flattened, *porose areas* subtriangular in outline, superficial, interporose interval about equal to maximum breadth; marginally basis capituli heavily pigmented, almost black, lateral margins diverge anteriorly, posterior margin straight, cornua short, broad basally and rounded apically; *palpi* relatively short and broad, article 1 short, broader than long, internal mesial spur present (Figure 30); article 2 swollen basally thence lateral profile concave to suture line with article 3, that of article 3 nearly straight and terminating in a broad rounded apex, mesially article 2 gently convex, article 3 straight and tapering to tip; *hairs* long on lateral and mesial profile of article 2, shorter on article 3; mesially, palp drawn out into a broad flange and long hairs arise on its mesial face, i.e. above and below the flange, length of article 2, 0.4 mm., article 3, 0.31 mm. Ventrally *basis capituli* broad, auriculae much reduced and form flattened projections (cf. with *I. pseudorasus*),

surface generally flat as far back as slight posterior depression, beyond which it rises strongly (stippled in Figure 31). Two pairs of hairs in positions indicated in Figure 31; posterior margin broadly rounded. *Hypostome* (Figure 17) long, rounded apically, largest teeth about mid-length, strongly pointed, dentition from base to apex, 7 rows 2/2, 4 rows 3/3, 2 rows 4/4, 2 rows 5/5 teeth, small "corona," median triangular unarmed area.

Scutum. Mean scutal dimensions are 1.3 mm. x 1.17 mm. (cf. with *I. pseudorasus,* 1.4x1.1), and the scutum is broadly rounded posteriorly (Figure 29), surface elevated between the short *cervical grooves; lateral carinae* ill-defined, antero-lateral margins slope steeply, scapulae short, rounded, emargination slight; *punctations* small, shallow, most abundant posteriorly but even so well separated, less numerous in the cervical field and between the cervical grooves and the lateral carinae.

Legs. Long and strong, *coxa* I with short, salient trenchant internal spur, coxa IV with short rounded external spur (Figure 20), trochanter spurs short, broad, pointed; *tarsus* I (Figure 22) long, narrow, slightly tapering, strongly humped beyond Haller's organ, *tarsi* II-IV with progressively weaker humps, hairs progressively shorter and stouter from leg I-IV; length of tarsus I, 0.76 mm., tarsus IV (Figure 24), 0.67 mm.

Spiracular plate. Almost rounded, macula anteriorly placed, large number of moderately large goblets (Figure 28).

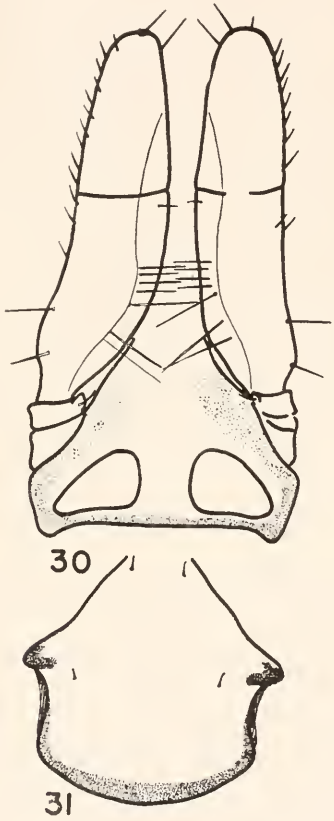
Genital aperture. Between coxae IV: genital apron slightly concave (Figure 25) (cf. with *I.pseudorasus* and *I.rasus*).

Anal grooves. Circular.

Description. MALE. From bovines, Sura, Arusha, Tanganyika, 13 Dec., 1955. F. W. White *leg.*

Body. Elongate oval, greatest width slightly in front of the middle, surface more steeply rounded posteriorly. Colour (of alcohol preserved specimens) alloscutum uniformly dark reddish brown, with many fairly long brownish white hairs especially on the periphery, hairs generally closely adherent to surface, scutum and basis capituli deep red brown with paler posterior and postero-lateral margins, legs and palpi less heavily pigmented.

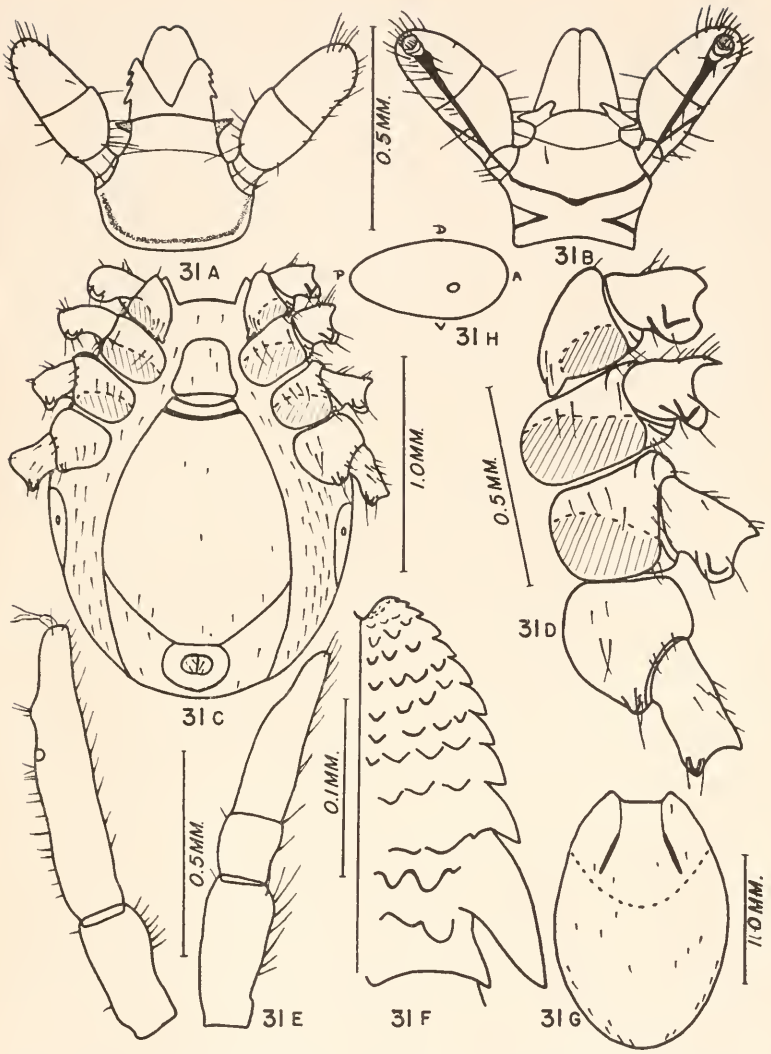
Capitulum (Figures 31A, B). *Basis capituli* about 1-3 times as broad as long, length 0.26 mm., breadth 0.34 mm., dorsal ridge broadly convex, more sharply rounded postero-laterally and thence to almost straight divergent margins, greatest width of basis capituli immediately behind palpal insertions. Surface of basis capituli reticulately patterned, elevated in mid-line behind anterior cheliceral foramen, broad depression on each side running antero-laterally from posterior margin to palpal insertions,



Figs. 30, 31. *Ixodes pseudorasus*, variant form, female: 30. Capitulum, dorsal; 31. Capitulum, ventral.

sloping away ventrally around base of latter, posterior margin weakly elevated. *Palpi* broad, short, length to breadth as about 2.6:1.0, taper from base to broadly rounded apex, articles 2 and 3 of about equal length, about 0.21 mm., lateral profile of article 3 indented baso-laterally thence slightly sinuous to the suture line between articles 2 and 3, that of article 3 almost straight; mesial margin of article 2 as a broad arc of a circle, that of article 3 straight and convergent to the rounded apex; greatest breadth of 0.16 mm. just below suture line of articles 2 and 3, hairs of moderate length and quite numerous apically. Ventrally posterior border concave, postero-lateral angles steep, lateral margins gently concave, diverging to palpal insertion; transverse ridge strongly defined, with auriculae as faintly curved and flange-like edges, connected by a median, broad, tongue-like ridge; basis capituli slightly longer than broad, less heavily pigmented than dorsal surface except for median tongue and auricular elevations of the ridge and periphery; surface slopes to hypostomal base from the transverse ridge, but short and declivitous behind the latter; two triangular elevations on either side of a depression behind, pair of erect hairs situated lateral and posterior to hypostomal base, mesial surface of both palpal articles 2 and 3 concave, that of 2 irregularly so. *Hypostome* (Figure 31F): broad, with indented apex, rounded on either side of the indentation, 12 lateral teeth increasing in size from apex to pre-basal teeth, basal tooth angular, teeth arranged as 2-3 rows of 3/3 files, 2 rows of 4/4 files, 4 rows of 5/5 files, pre-basal and basal tooth subtended by two crenulations each; length 0.23 mm.

Scutum (Figure 31G). Colour uniformly deep red brown, with smaller less heavily pigmented patches antero-lateral to scapulae. Elongate oval, tapering a little anteriorly, steeply rounded posteriorly, greatest breadth approximately at mid-length, length 1.93 mm., breadth 1.30 mm., distance between the scapulae, 0.38 mm., antero-lateral margins behind scapulae undulate, lateral and postero-lateral margins curved, *lateral carinae* lacking, *cervical grooves* faint and very shallow, most apparent in front of the pseudoscutal outline, weak behind the scapulae.



Figs. 31A-H. *Ixodes pseudorasus* male: A. Capitulum, dorsal; B. Capitulum, ventral; C. Opisthosoma, ventral; D. Coxae I-IV; E. Tarsi I and IV; F. Hypostome; G. Scutum; H. Spiracular plate.

Punctations numerous, subequal, shallow, small, more or less evenly distributed over the surface. Scapulae broad based, short, subtriangular with blunt apices, emargination moderate. *Hairs* white, small, fairly numerous, uniformly distributed over the surface.

Ventral plates (Figure 31C). Pregenital plate slightly concave behind, convergent sides, rounded anteriorly, extends from anterior margins of coxae III to posterior margin of coxae I; median plate about one and a third times as long as broad, greatest breadth very near to posterior margin, sides curved and convergent to genital opening; adanal plates subrhomboidal with sharp anterior angles, posterior junction between adanal plates on either side ill-defined or absent; anal plate transversely oval and drawn out into a small point posteriorly.

Legs (Figure 31D). Broad, long, *coxae* I-III with extensive syncoxal areas; all coxae large and broad, coxae I with strong, conical internal spur, II and III unarmed, IV with smaller rounded, broad external spur, several long hairs on each coxa, with posterior margins of coxae I-III strongly trenchant, trochanters I and II with large, broad-based spurs, III with a similar but more flange-like spur, IV with smaller, more slender pointed spur: *tarsi* (Figure 31E) long with slight hump, length of tarsus I, 0.67 mm., metatarsus I, 0.32 mm., tarsus IV, 0.57mm., metatarsus IV, 0.38 mm.

Spiracular plate (Figure 31H). Large, elongate oval, broadly rounded in front, narrower behind, long axis parallel to that of body, length 0.36 mm., breadth 0.22 mm., macula anteroventral.

Genital orifice. On a level with the anterior edges of coxae III, genital aprou slightly indented.

Hosts of Ixodes pseudorasus. Leopard, goat, cattle, bushbuck, *Neotragus moschatus akeleyi*, man, dog, *Cricetomys gambianus*, *Cephalophus, Mungos melanurus*, giant rat, *Okapia* (which appears to be a frequent host in Belgian Congo), *Centropus superciliosus, Neotragus pygmaeus, Potamochoerus porcus, Tragelaphus scriptus*, "*tick-bird*," Chevrotain, forest antelope, bovines.

Biology. On larger mammals the adults occur on the ears and thighs of hosts. Immature stages probably occur on small mammals but until breeding experiments of these stages are completed it is inadvisable to name possible hosts.

Related species. Confusion regarding the *Ixodes rasus* group has arisen because of the acceptance of the closed anal groove as the sole diagnostic character, which is based on the key prepared by Nuttall, Warburton, Cooper and Robinson (1911). At present we recognize the following five species having closed circular grooves: *I. rasus* Neumann, *I. pseudorasus,* sp. nov., *I. muniensis* sp. nov. *I. procaviae* sp. nov. and *I. thomasae* sp. nov. The affinities between *rasus* and *pseudorasus* are to be found only in the form of the anal groove and the long palps. A comparison of the descriptions and figures reveal that the differences in the form of the auriculae, the spurs on coxae I and IV and in the shape of the genital apron constitute distinctive characters. Both species have a similar geographical range and if *I. rasus* and *I. pseudorasus* are to be considered as variations within the species, as suggested by Nuttall *et al.* (*loc. cit.*) then all grades of intermediates would be expected. This is not so and out of 140 females examined 43 belong to *I. rasus* and 97 to *I. pseudorasus* with no trace of intermediate forms. Whether the variants of *I. pseudorasus* from Costermansville, all of which agree among themselves, should have subspecific rank is problematical as only nine females were available for examination, and far more collecting for this tick is desirable.

Remarks. Nuttall, Warburton, Cooper and Robinson (1911) base their description on females from Uganda (GHFN 877a), Oubasi (GHFN 503) and from man and dog, Kumasi, Ashanti. It would appear that these authors did not see the type and concluded that their description of the female differed from that of Neumann (1899).

Ixodes muniensis sp. nov.

(Figures 32—51)

Holotype. Female, from *Cephalophus* sp. "Mongele," Epulu River, Ituri district, Belgian Congo, P. Putnam *leg.* Deposited in Museum of Comparative Zoology, Harvard University.

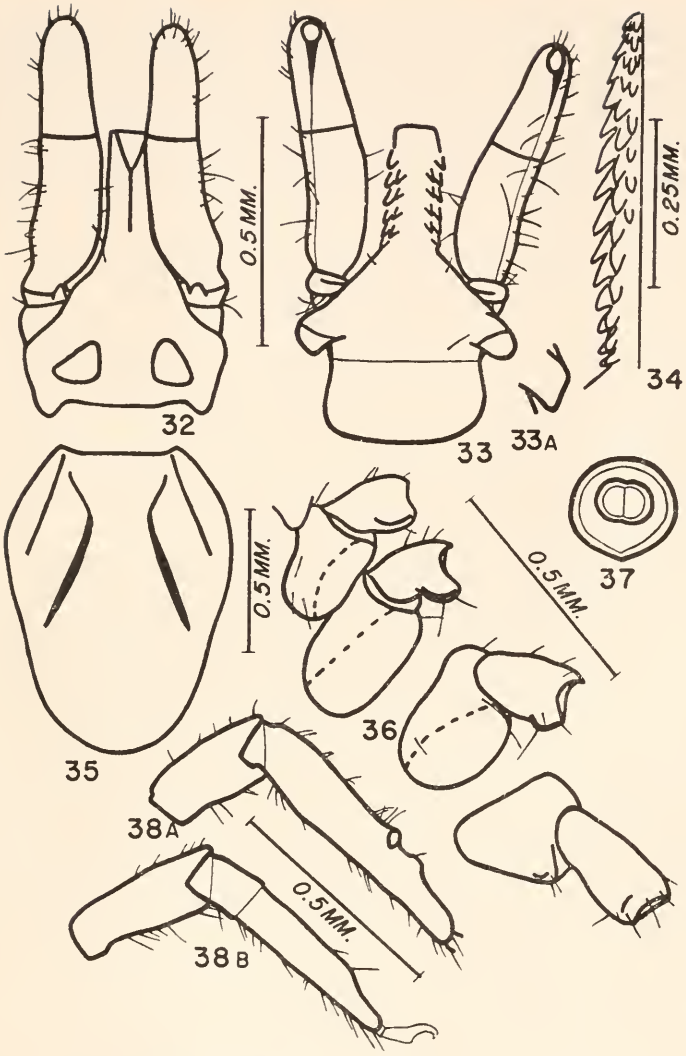
Paratypes. Total 3 females, 9 nymphs and 8 larvae, all from the same host as the holotype and deposited in the Museum of Comparative Zoology, Harvard University.

MATERIAL EXAMINED. Total 13 females, 15 nymphs, 8

larvae. 1 female, 3 nymphs ex Duiker, north central Rio Muni 24 May, 1954, K. C. Brown *leg.*, gift of Col. R. Traub to HH No. B.22842; 1 female, 1 nymph, tabby cat, north central Rio Muni, 23 April, 1954, K. C. Brown *leg.*, gift of Col. R. Traub to HH No. B.22836; 3 females, 2 nymphs, forest antelope, north central Rio Muni, 10 June, 1954, K. C. Brown *leg.* gift of Col. R. Traub to HH No. B22845; 1 female, *Neotragus pygmaeus,* Yapo, Ivory Coast, A. Villiers *leg.* (MCZ); 1 female, *Felis pardus,* primary forest, 12.5.1933, 500 ft. Mainyu Bridge, Mamfe, Cameroons, I. T. Sanderson *leg.* P. Sladen Trust Expedition (BM 1954 6.14.52); 2 females, tube No. 20 (no host data); Yokadouma, Cameroons, 30.5.55 (JM).

Description. FEMALE. Body, oval-oblong. Alloscutum cream, few short curved white hairs in alcohol preserved specimens, sclerotised parts medium brown, except for more heavily pigmented basis capituli, maximum width slightly in front of spiracle; anal aperture near posterior border; genital orifice level with posterior edge of coxae IV, genital apron unilobed; scutum reaches back beyond half the opisthosomatic length in unfed or partly fed specimens.

Capitulum (Figures 32, 33). *Basis capituli* deep reddish-brown, approaching black peripherally; posterior margin between cornua slightly convex, cornua large, sub-triangular, rounded apices; lateral margins slightly divergent to greatest width at palpal base; surface of basis reticulately patterned, elevated in mid-line, slightly convex to antero-lateral margins being more emphasized near the hypostomal base. *Porose areas* indistinct, sub-triangular, shallow, inter-porose length about equal to breadth of porose areas. *Palpi* long, rounded apically, tapering most strongly distal to suture line between articles 2 and 3, lateral profile of article 2 swollen latero-basally, thence gently concave to suture line; mesial profile of article 2 convex proximally, greatest breadth occurs about half-way along article 2, article I with prominent dorsally-directed flange-like projection (Figure 32), *hairs* long, fine, especially laterally, fewer in number mesially. Ventrally *basis capituli* slightly longer than broad, greatest breadth across auriculae, posterior border broadly curved, lateral borders slightly constricted (Figure 33), auriculae large, flat, broad-based, lobes, directed ventrally, pair of small



Figs. 32-38B. *Ixodes muniensis*, female: 32. Capitulum, dorsal; 33. Capitulum, ventral; 33A. Variation in the auricular form of the female; 34. Hypostome; 35. Scutum; 36. Coxae and trochanters I-IV; 37, Anal plate; 38A. Tarsus and metatarsus I; 38B. Tarsus and metatarsus IV.

hairs mesial to auriculae, similar pair posterior and lateral to hypostomal base. Palpal article 1 produced into a prominent pointed spur ventro-laterally and supplied with two hairs; mesial surface of article 2 flat, that of article 3 slightly concave. *Hypostome* (Figure 34), long, tapering, slender, apex rounded; dentition from base to apex consists of six rows of 2/2, 6 rows of 3/3, 2 rows of 4/4, small "corona."

Measurements (in mm.) of 10 females of *I. muniensis*

	Holotype specimen	Average	Smallest	Largest
Length of capitulum from dorsal ridge	0.31	0.31	0.30	0.32
Breadth along dorsal ridge	0.35	0.36	0.34	0.39
Breadth across auriculae	0.46	0.45	0.41	0.48
Length of palpal article 2	0.32	0.32	0.29	0.34
Length of palpal article 3	0.25	0.24	0.23	0.27

Scutum (Figure 35). Medium brown colour in alcohol preserved specimens; long, greatest width anterior of mid-length, antero-lateral margins gently convex, postero-lateral margins weakly concave before terminating in rounded posterior margin; *lateral carinae* as short ridged elevations not extending to the margins, lateral field slopes gently from the ridge; *cervical grooves* shallow, becoming broadest about mid-length, not attaining postero-lateral border, convergent at first then divergent postero-laterally. *Punctations* equal, moderate-sized, distinct, shallow, more numerous posteriorly than anteriorly, absent beyond carinae. Scapulae very short, broad, blunt, emargination almost negligible, hairs few, scattered, longer and more numerous anteriorly between cervical grooves.

Measurements of scutum of 10 females (in mm.)

	Holotype female	Average	Smallest	Largest
Length of scutum	1.08	1.09	1.02	1.16
Breadth of scutum	0.76	0.80	0.72	0.83

LEGS. Long, slender, *coxae* I, II, and III (Figure 36) with extensive syncoxal areas, internal angle of coxa I slightly trenchant, internal spurs lacking; coxae IV, subtriangular, small postero-external spur; *hairs* slender, white, prominent broad flange-like saliences on trochanters II and III reduced salience on trochanter I. *Tarsi* (Figures 38A, 38B) relatively long and thin with numerous hairs of moderate length.

Measurements of tarsi and metatarsi of 10 females (in mm.)

	Holotype female	Average	Smallest	Largest
Length of tarsus I	0.62	0.59	0.55	0.62
Length of metatarsus I	0.31	0.30	0.29	0.32
Length of tarsus IV	0.53	0.53	0.51	0.55
Length of metatarsus IV	0.35	0.34	0.33	0.37

SPIRACULAR PLATE. Oval, long axis transverse to that of body, macula slightly ventrally placed, dimensions, holotype female, 0.23 mm. x 0.18 mm., average size based on 10 females, 0.23 mm. x 0.19 mm., smallest, 0.20 m. x 0.17 mm., largest, 0.24 mm x 0.21 mm.

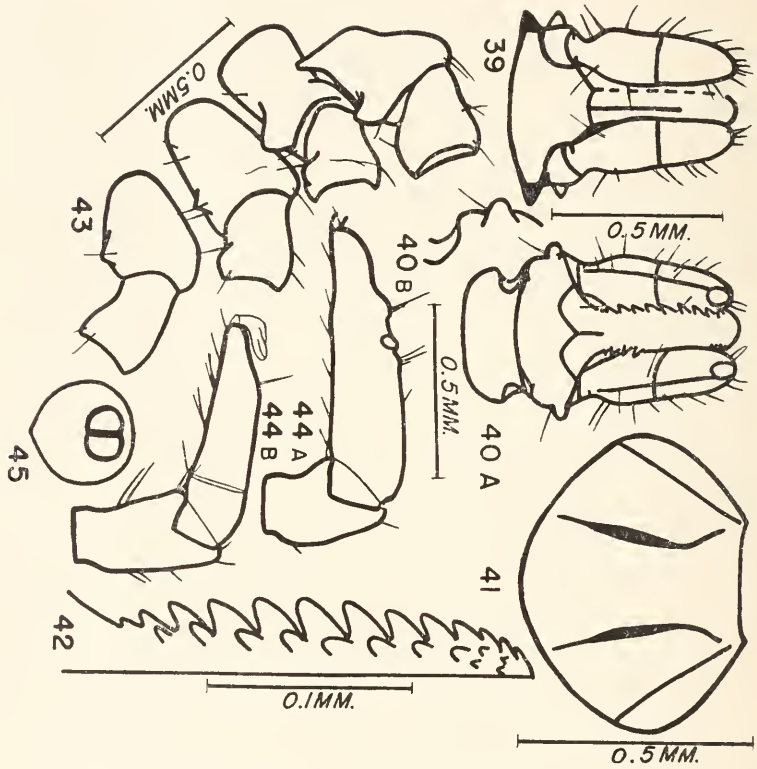
ANAL GROOVES (Figure 37). Circular, closed, ending in a slight point behind.

GENITAL ORIFICE. Level with posterior margin of coxae IV, small, crescentic, unilobed genital apron.

Description. NYMPH. *Body* broadly rounded posteriorly, narrowing anteriorly, greatest width just behind level of coxae IV; in alcohol preserved nymphs alloscutum pale cream, with curved white hairs of moderate length, legs, pale brown: anterior half of scutum and palps more heavily pigmented but less so than basis capituli, scutum reaches back to about one-third of opisthosomatic length in unfed or partially gorged specimens.

CAPITULUM (Figures 39, 40A, 40B). *Basis capituli* twice as broad as long, yellow-brown centrally, reddish-brown peripherally, dorsal ridge gently convex and extended to lateral points, cornua lacking, antero-lateral margins sharply convergent to palpal base; surface of basis reticulately patterned and elevated near dorsal ridge, gently sloping ventro-laterally, but becoming steeper along the antero-lateral margins. *Palpi* relativly short, article 2 (0.12-0.13-0.15 mm.) slightly longer than article 3 (0.095-0.11-0.12 mm.); tapering distinctly along length of article

3, lateral profile strongly constricted basally, thence almost straight to the suture between articles 2 and 3, greatest breadth about mid-length of article 2, article 3 rounded apically; mesially article 1 has a small dorsally directed flange-like projection, *hairs* long on lateral profile and basally on article 2, fewer in number mesially, tuft of smaller hairs apically. Ventrally *basis capituli* has straight posterior border, postero-lateral angles rounded converging to well defined "waist," auriculae consist of bilobed flat-



Figs. 39-45. *Ixodes muniensis*, nymph: 39. Capitulum, dorsal; 40A. Capitulum ventral; 40B. Auricula; 41. Scutum; 42. Hypostome; 43. Coxae and trochanters I-IV; 44A. Tarsus and metatarsus I; 44B. Tarsus and metatarsus IV; 45. Anal plate.

tened projections with rounded apices, directed postero-laterally, with the more posterior lobe ventrally inclined; a prominent postero-laterally directed hair between the lobes, auriculae connected by strong curved transverse ridge, becoming less elevated in mid-line; surface reticulately patterned, yellowish-brown centrally, deeper reddish-brown peripherally. Surface convex behind the ridge but flat in front, pair of moderate length hairs posterior and lateral to hypostomal base. Mesial surfaces of both palpal articles 2 and 3 flat. *Hypostome.* Length of hypostome figured (Figure 42), 0.26 mm.; mean length, 0.24 mm., shortest, 0.22 mm., longest, 0.26 mm., greatest width about mid-length, tapering to rounded apex, denticles broad, blunt, arranged in 8 rows of 2/2, 2 rows of 3/3.

Measurements of 15 nymphs (in mm.)

	Average	Smallest	Largest
Length of capitulum from dorsal ridge	0.13	0.12	0.15
Breadth along dorsal ridge	0.29	0.26	0.31
Breadth across auriculae	0.29	0.25	0.34

Scutum. Length, 0.47 - 0.53 - 0.57 mm., breadth, 0.55 - 0.60-0.63 mm., colour pale to medium brown; transversely ovate, antero-lateral margins converge to scapulae in slight convexity with minor undulations, postero - lateral margins behind greatest breadth converge more strongly to broadly rounded posterior margin; *lateral carinae* as slight straight elevations fading into general elevation of scutum anteriorly and widening postero-laterally, lateral field slopes gently peripherally; *cervical grooves* shallow, widest about mid-length, fading posteriorly and not attaining postero-lateral margins, divergent in front: scapulae minute, broad, blunt, emargination weak. *Punctations* few in number, small and shallow of equal size, most abundant posteriorly; few short white adpressed hairs, most dense on lateral fields.

Legs. Moderate size, *coxa* I (Figure 43) with moderate sized pyramidal pointed external spur and longer conical pointed internal spur, coxae II, III and IV with successively decreasing pyramidal, pointed spurs, few hairs of varying lengths on each

coxa, small flange-like saliences on trochanters I-III. *Tarsi* (Figures 44A, 44B) relatively short, broad, with slight hump distal to Haller's organ on tarsus I; length of tarsus I, 0.37 - 0.41 - 0.44 mm., metatarsus I, 0.17 - 0.18 - 0.19 mm.; tarsus IV, 0.29 - 0.34 - 0.36 mm., metatarsus IV, 0.18 - 0.22 - 0.23 mm.

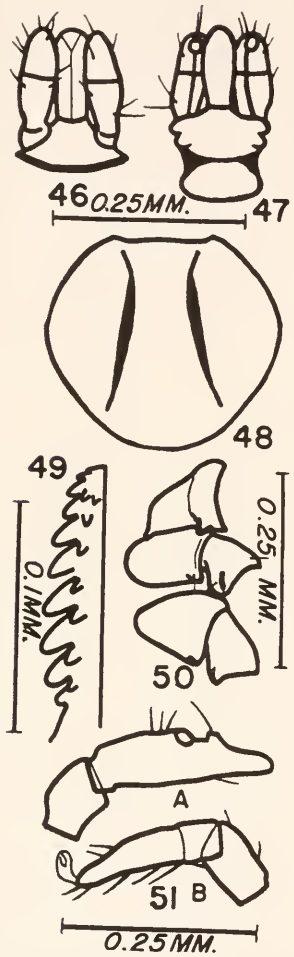
Spiracular plate. Oval, longitudinal axis transverse to that of body, macula ventral and slightly anterior of center, dimensions: average 0.16 mm. x 0.14 mm., smallest 0.12 mm. x 0.11 mm., largest 0.17 mm. x 0.17 mm.

Anal grooves. Oval, long axis parallel to that of body, closed, circular terminating in a slight point behind (Figure 45).

Description. LARVA. Fully fed larvae almost elliptical in shape, in alcohol preserved specimens alloscutum black, few scattered short, curved white hairs, legs and palpi pale brown, basis capituli medium brown, scutum yellow or dark brown with yellowish margins, scutum reaches back to less than a quarter of opisthosomatic length in fully fed specimens, greatest width about mid-length, anal grooves closed, circular.

Capitulum. Total length of capitulum, 0.19 mm., breadth across dorsal ridge, 0.15 mm. *Basis capituli* twice as long as broad (Figures 46, 47) dorsal ridge convex, drawn out to lateral points, no cornua; lateral margins short, strongly convergent to palpal bases; surface of basis capituli reticulately patterned, elevated into two prominent mounds mesial of palpal bases, depressed in mid-line behind hypostome, gentle slope antero-laterally, becoming steeper along rostral margins: *Palpi* short, article 2 (0.065 mm.) a little longer than article 3 (0.058 mm.), lateral profile of article 2 indented basally, thence gently convex to apex, mesially article 2 almost straight and article 3 terminates in a fairly acute rounded apex, long hairs present laterally, fewer mesially; mesial surface of articles 2 and 3 flat. Ventral view (Figure 47) posterior margin of venter of *basis capituli* slightly curved, posterolateral angles gently rounded, constricted laterally; auriculae as in nymph, each lobe flattened ventrally, subtriangular with blunt apices, directed more or less laterally, breadth across auriculae, 0.13 mm., strong curved transverse ridge, auriculae elevated above posterior extension of *basis capituli*: surface reticulately patterned; anterior to transverse ridge, pale brown, behind ridge more heavily pigmented. *Hypostome* (Figure 49) short, approximately parallel-sided,

rounded apex with broad "corona," succeeded by 1 row of 3/3, 6 rows 2/2, 1 row 1/1; length 0.13 mm.



Figs. 46-51B. *Ixodes muniensis*, larva; 46. Capitulum, dorsal; 47. Capitulum, ventral; 48. Scutum; 49. Hypostome; 50. Coxae I-III and trochanters II-III; 51A. Tarsus and metatarsus I; 51B. Tarsus and metatarsus III.

Scutum. Colour variable in alcohol preserved specimens, e.g., black, yellow, black with yellow margins—black with paler coloration anteriorly: about as broad as long, length 0.29 mm., breadth 0.29 mm., greatest breadth at about mid-length, antero-lateral margins curve gradually to almost negligible scapulae, lateral margins rounded, *lateral carinae* very slight elevations close to antero-lateral margins; *cervical grooves* shallow, widest about midway along, narrowing appreciably behind and not reaching postero-lateral margins. *Punctations* very few, equal, indistinct, small and shallow, confined to posterior and lateral portions of scutum; specimens examined glabrous.

Legs. Moderate length and thickness, *coxa I* (Figure 50) with pointed, horn-like external spur, smaller conical internal spur, few long hairs on coxae; small flange-like saliences on trochanters I and III, largest on II. *Tarsi* (Figures 51A, B) with several long hairs, tarsus I broad, humped, length of tarsus I, 0.22 mm., length of metatarsus I, 0.1 mm.; length of tarsus III, 0.20 mm., length of metatarsus III, 0.1 mm.

Anal aperture. Fairly near posterior border; anal grooves closed, circular.

Related species. I. muniensis, like *I. rasus* and *I. pseudorasus,* is not a host specific tick and appears from the limited data available to be a West African species. This new species is readily recognizable from other species of the *rasus* group by the characters which appear in the key (p. 535). Males are unknown.

Hosts. Cephalophus, duiker, tabby cat, forest antelope, *Neotragus pygmaeus, Felis pardus.*

Ixodes procaviae new species

(Figures 52-72)

Holotype. Female, from *Dendrohyrax adolfifriederici,* Kisenyi, Belgian Congo, 6 September, 1949. Deposited in the Rocky Mountain Laboratory, Hamilton, Montana, U. S. A. Number (25) 27839.

Allotype. Male, no host or locality data, Rocky Mountain Laboratory, Hamilton, Montana, U. S. A. Number 26006.

Paratypes. 2 females, 1 male, 1 nymph. Data as for allotype

and all deposited in the Rocky Mountain Laboratory, Hamilton, Montana, U. S. A.

OTHER MATERIAL EXAMINED. Total, 15 females, 2 males, 1 nymph. 3 females, *Procavia adolfifriederici* Brauer, Burunga, Belgian Congo, H. Schouteden *leg.* (MC); 5 females, *Procavia ?,* Burunga, Kini, -.12.1925, H. Schouteden *leg.* (MC 8178–8182); 1 female, *Phacochoerus* sp., Bururi, 1.6.1949, J. Francois *leg.* (MC 68842); 1 female, *Dendrohyrax arboreus,* Kisenyi, Ruanda, J. Deom *leg.* (MC 72375); 2 females, Rift Valley Province, Kenya (HH collection).

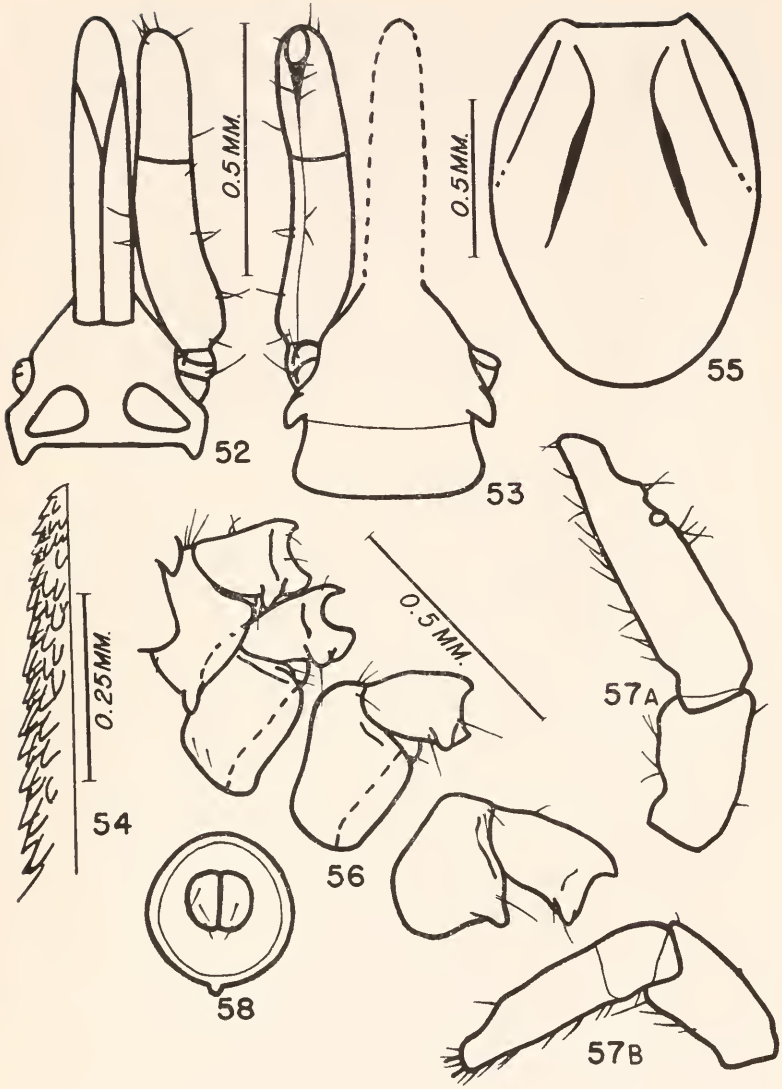
Description. FEMALE. Elongate oval, tapering more strongly anteriorly, maximum width just in front of spiracle; anal aperture situated far back, scutum reaches back beyond half opisthosomatic length. Alloscutum dark grey in alcohol preserved specimens, with white hairs closely applied to the body.

Capitulum. *Basis capituli* average length from dorsal ridge to rostral base 0.30 mm. (holotype 0.26 mm., range 0.26-0.32 mm.), average breadth across dorsal ridge, 0.37 mm. (holotype 0.37 mm., range 0.34 - 0.39 mm.); dorsal ridge straight between cornua, latter well-developed, relatively slender, subtriangular with blunt salient apices; lateral margins carinate, slightly diverging anteriorly to level of palpal insertion; surface reticulately patterned, flat except for pronounced lateroventral curvature in the rostral region. *Porose areas* distinct, of moderate extent, piriform, moderately depressed, separated by an interval about equal to their maximum breadth (Figure 52). *Palpi,* long, slender about five times as long as the greatest width; apex broadly rounded with more acute curvature mesially; mean length of article 2, 0.40 mm. (holotype, 0.42 mm., range 0.39 mm. -0.42 mm.); article 3, 0.25 mm., (holotype, 0.26 mm., range 0.23 mm. -0.26 mm.); lateral profile of article 2 strongly indented baso-laterally, thereafter distinctly concave to the suture line between articles 2 and 3, article 3 with straight or slightly convex lateral outline; mesial profile of article 2 convex, that of 3 almost straight; article 1 broader than long with small, pointed dorsally directed spur, situated close to meso-dorsal margin; bristles few, moderate to long. *Basis capituli* more heavily pigmented ventrally than dorsally, posterior border straight with prominent, rounded postero-lateral extensions (Figure 53), lateral margins slightly constricted behind auriculae, latter short,

flattened backwardly-directed horns narrowing to their tips and directed postero-ventrally; palpal article 1 possessing a saddle-shaped spur adjacent to antero-lateral margin of *basis capituli*, two fine white hairs arise dorsal to this spur; mesial surface of article 2 flattened, that of 3 slightly indented. *Hypostome* (Figure 54), average length 0.59 mm., (holotype, 0.60 mm., range 0.57 mm. -0.60 mm.), tapering slightly from base to apex which is domed, denticles long, slender becoming slightly shorter towards the mid-line, dentition from base to apex as 2 rows of 2/2 files, 3 rows of 3/3 files,, 3 rows of 4/4 files, 6 rows of 5/5 files surmounted by a small "corona."

Scutum. Colour brown, elongate oval in shape with greatest width in front of mid-length, average length, 1.24 mm., (holotype, 1.25 mm., range 1.18 — 1.27 mm.), average breadth, 0.86 mm., (holotype, 0.88 mm., range 0.80 — 0.89 mm.). Antero-lateral margins converge to broad, blunt, short scapulae (Figure 55) by a few minor undulations, behind greatest width convergent margins either rectilinear or slightly concave and terminate in broadly rounded posterior extremity. *Lateral carinae* as slight, straight elevations which are most pronounced about three quarters of their length posteriorly, lateral field slopes strongly from the carinae. *Cervical grooves* strongly convergent posteriorly before becoming divergent for the greater part of their length, shallow and narrow at first subsequently broadening, do not attain postero-lateral borders. *Punctations* small to medium-sized, distantly spaced and more numerous posteriorly than anteriorly. *Hairs* few, irregularly dispersed but most frequent anteriorly between the cervical grooves.

Legs. Long. *Coxae* I, II and III with small syncoxal areas (cf. *Ixodes muniensis*), trenchant behind, prominent sharp postero-internal spur on coxa I which may or may not reach to or slightly overlap the anterior margin of II, postero-internal angle of II forms a marginal salience, long tapering external spur on coxa IV; coxae each supplied with a variable number of long white hairs. Each trochanter supplied with long, sharp spurs (longer than indicated in Figure 56). *Tarsi* with dorsal surface converging slightly to Haller's organ (Figure 57A), and followed



Figs. 52-58. *Ixodes procaviae*, female: 52. Capitulum, dorsal; 53. Capitulum, ventral; 54. Hypostome; 55. Scutum; 56. Coxae and trochanters I-IV; 57A. Tarsus and metatarsus I; 57B. Tarsus and metatarsus IV; 58. Anal plate.

by a moderate sub-apical hump, the latter is less well defined on tarsi II-IV, hairs becoming stronger and shorter from tarsi I to IV; average length of tarsus I, 0.61 mm. (holotype, 0.62 mm., range 0.57 mm. — 0.63 mm), metatarsus I, 0.32 mm. (holotype, 0.32 mm., range 0.31 mm. — 0.32 mm.); tarsus IV, 0.51 mm., (missing in holotype, range 0.49 mm. — 0.52 mm.); metatarsus IV, 0.34 mm. (missing in holotype, range 0.33 m. — 0.35 mm).

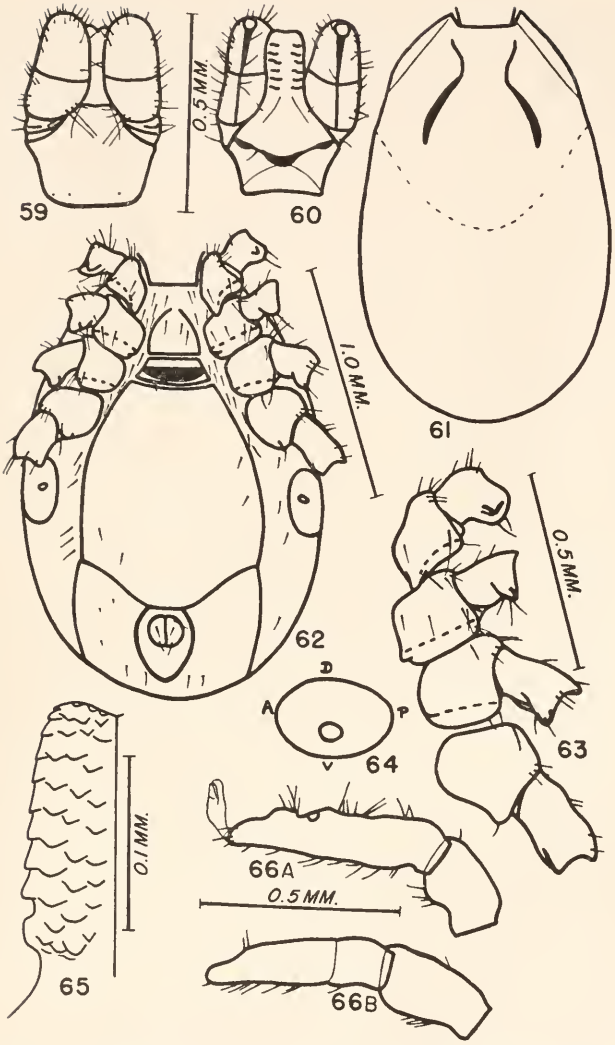
Spiracular plate. Slightly ovate, long axis transverse to that of body, macula slightly anterior of center; dimensions, mean, 0.25 x 0.21 mm., holotype, 0.23 x 0.20 mm., range, 0.22 — 0.26 mm. x 0.19 — 0.23 mm.

Anal groove. Oval, closed and in some specimens terminates in a small point, long axis parallel with corresponding axis of body (Figure 58).

Genital orifice. On a level with posterior margin of coxae IV; narrow, long crescentic.

Description. MALE. Elongate oval, but tapering quite strongly in front with a broad posterior extremity. Length from tip of palpi to posterior body margin 2.13 mm.; greatest body width at the level of the spiracles 1.25 mm., body flat. Colour of alcohol preserved specimens, medium brown alloscutum, sclerotized parts golden brown.

Capitulum. Overall length from dorsal ridge to palpal tips 0.49 mm., greatest breadth behind palpal insertion, 0.31 mm., breadth across dorsal ridge, 0.22 mm. *Basis capituli* (Figure 59) broader than long, mid-region golden brown, black peripherally, posterior margin straight, postero-lateral angles rounded, sides divergent to base of palps; surface irregularly sculptured, convex medianly behind cheliceral "foramen," otherwise flattened except for a slight elevation along the posterior ridge, few scattered small pores. *Palpi*, short, broad, globular, about twice as long as the greatest breadth; dorsally article 2 slightly longer than article 3 (as 0.15 mm. is to 0.14 mm.), with the greatest width at the apex of article 2; apex broadly rounded; lateral margin of article 2 swollen basally then either straight or gently concave to suture, profile of article 3 straight, mesial margin of articles 2 and 3 broadly convex; *hairs* of moderate length, fine particularly laterally, two long strong hairs arise mesodorsally and basally from article 2. Ventrally (Figure 60) basal margin either straight or faintly concave, lateral margins concave, di-



Figs. 59-66B. *Ixodes procaviae*, male: 59. Capitulum, dorsal; 60. Capitulum, ventral; 61. Scutum; 62. Venter; 63. Coxae and trochanters I-IV; 64. Spiracular plate; 65. Hypostome; 66A. Tarsus and metatarsus I; 66B. Tarsus and metatarsus IV.

vergent: auriculae as small, raised lips linked by a transverse ridge to form a broad, tongue-shaped eminence in the midline, gentle slope from the ridge anteriorly; steeper, sharper slope posteriorly; one pair of small white hairs — one on each side lateral to and behind the hypostomal base, second pair of hairs on ridge between the auriculae and the median tongue-shaped eminence; mesial surfaces of articles 2 and 3 slightly concave. *Hypostome* (Figure 65) short (0.22 mm.), broad, tapering, and indented apically. Dentition consists of at least 7 rows of crenulations arranged in 4/4 files.

Scutum. Colour, medium to dark brown. Scutal surface very slightly convex centrally, gradually downcurved laterally, long oval in shape (Figure 61) but narrowing more strongly in front than behind, length 1.69 mm., breadth 1.05 mm. *Cervical grooves* short, not extending back to the level of the faintly indicated pseudoscutum, slightly converging and thence widely divergent, shallow — narrow initially before broadening. *Punctations* numerous, shallow, small, fewer in number anteriorly. Scapulae short, broad sharp; emargination moderate. *Hairs* few, short, white more abundant posteriorly than anteriorly.

Legs. Moderate length and breadth. *Coxae* I, II and III with relatively small syncoxal areas, coxa I with distinct broad tapering postero-internal spur, coxa II with short internal spur mesially and forward of the postero-internal position, coxa IV with broad-based conical external spur; coxae I and II trenchant behind. Several hairs of varying length on all coxae. *Trochanters* I, II and III with prominent conical spurs, that on IV less pronounced — these spurs are not as strong as the comparable ones in females. *Tarsi* humped, broad, with moderate to long hairs; length of tarsus I, 0.54 mm., metatarsus I, 0.25 mm.: tarsus IV, 0.46 mm., metatarsus IV, 0.30 mm. (Figures 66A, B).

Spiracular plate. Elongate oval (Figure 64) long axis parallel to that of body, goblets numerous, macula anteroventral; dimensions 0.20 mm. x 0.28 mm.

Ventral plates. *Pregenital plate* with straight posterior edge, lateral margins curved and converging anteriorly; *median plate* large, much wider behind than in front, lateral and posterior

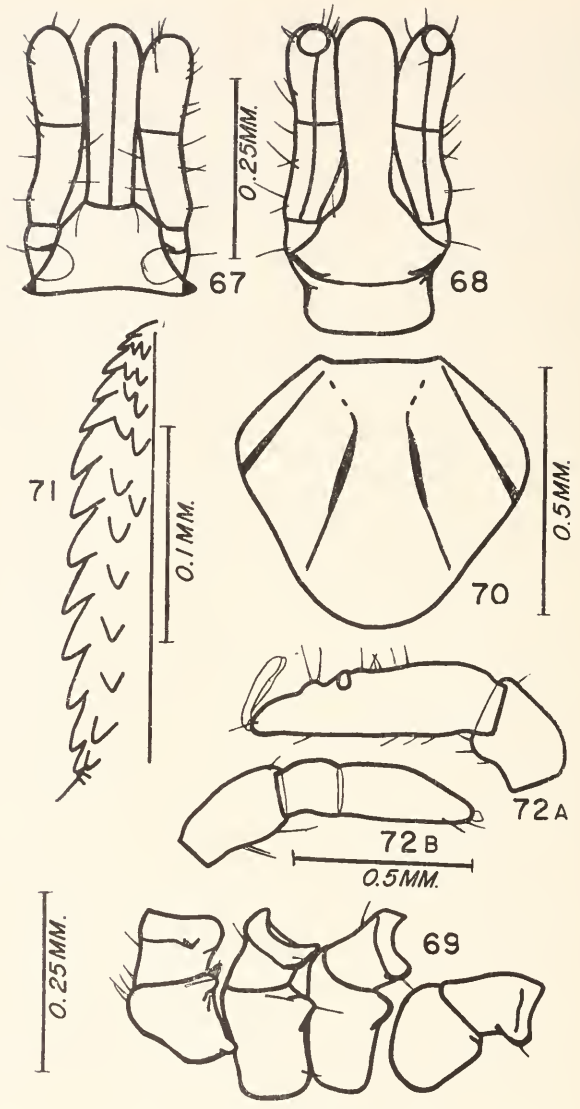
margins curved (see Figure 62); *adanal plates* almost rhomboidal, sides adjacent to anal plate incompletely concave; *anal plate* almost egg-shaped with anterior edge flattened; small transverse subrectangular plate between genital orifice and pregenital plate.

Genital orifice. Wide, located between coxae III.

Description. NYMPH (described from a single specimen from lot RML—26006). *Body* shape as in female except that the greatest width occurs across coxae IV; has some of the salient characters of the female.

Capitulum. Length, 0.30 mm., breadth across auriculae 0.20 mm., breadth across dorsal ridge, 0.245 mm., *basis capituli* about twice as broad as long, dorsal ridge slightly concave, and produced to salient lateral projections, which mark the greatest width, lateral margins very short and sharply convergent to palpal insertions; surface reticulately patterned, gently convex except for a slight elevation along the dorsal ridge, and strong slope peripherally. *Palpi* long, club shaped, length of article 2, 0.16 mm., length of article 3, 0.14 mm., article 3 stouter than article 2, greatest breadth 0.05 mm. Article 2 swollen basally for a short distance thence concave to the rounded palpal apex, mesial profile of articles 2 and 3 broadly convex; article 1 with small mesodorsal spur, *hairs*, long, particularly laterally. Ventrally, posterior edge of *basis capituli* straight (Figure 68), posterolateral edges sharply rounded, sides slightly constricted; auriculae small flange-like lobes, not particularly elevated above surface, more heavily pigmented than rest of basis; pair of small hairs placed posterior and lateral to hypostomal base, one long curved white hair on each side in front of auriculae; palpal article 1 with small elongate saddle-shaped spur, mesial surface of article 2 flat, that of 3 concave. *Hypostome* length, 0.26 mm., profile curved, apex rounded, external teeth larger than internal teeth, dentition from apex to base as 5 rows of 3/3 files, 6 rows of 2/2 files (Figure 71).

Scutum. Colour, brown beyond cervical grooves, paler in between latter and posteriorly. Large, nearly as broad as long; length 0.54 mm., breadth 0.52 mm., greatest breadth about one-



Figs. 67-72B. *Ixodes procaviae*, nymph: 67. Capitulum, dorsal; 68. Capitulum, ventral; 69. Coxae and trochanters I-IV; 70. Scutum; 71. Hypostome; 72A. Tarsus and metatarsus I; 72B. Tarsus and metatarsus IV.

third distance from scapulae, latter short, broad, blunt; antero-lateral margins almost rectilinear, convergent to scapulae, at greatest width sharply angled (Figure 70) thence by slightly sinuous postero-lateral sides to broadly rounded posterior extremity; *lateral carinae* as minor elevations, becoming wider and losing height as lateral margins reached, short, straight; lateral field slopes gently from the ridge; *cervical grooves* convergent, indistinct and shallow anteriorly, then diverging, widening but not attaining postero-lateral margins. *Punctations* distinct, few, small, shallow, most numerous behind greatest breadth; *hairs* short, white, most prominent anteriorly and laterally.

LEGS. Of moderate length and thickness. *Coxa* I with sharp pointed, conical, internal and external spurs (Figure 69), coxae II and III with moderate-sized, round-ended, pyramidal, external spurs, coxa IV, with broad-lobed external salience; posterior margin of coxa I and postero-external angle of coxa IV trenchant. *Trochanter* spurs on all coxae, that on I being small and conical, on II-IV broad, flange-like. *Tarsi* (Figures 72A, B) taper gradually from proximal to distal end, slight pre-apical hump on I, becoming less well defined from II to IV; length of tarsus I, 0.36 mm., metatarsus I, 0.15 mm.; tarsus IV, 0.28 mm., metatarsus IV, 0.17 mm.

SPIRACULAR PLATE. 0.12 mm. x 0.10 mm., long axis transverse to that of body, macula almost centrally placed.

ANAL GROOVE. Oval, slightly open behind, longitudinal axis parallel to that of body.

LARVA. Unknown.

Related species. The females of *procaviae* and *thomasae* agree in the form of their auriculae and the spurring of coxae I and II, apart from the closed anal groove. The postero-lateral extension of the venter of the basis capituli together with the long, tapering trochanter spurs make it readily distinguishable from other members of the *rasus* complex of species.

Hosts. Dendrohyrax adolfi-friederici, Dendrohyrax arboreus, Procavia, Phacochoerus sp. (Names of hosts given here are as on data enclosed with the specimens in the tubes.)

Remarks. At present known only from the Belgian Congo, Uganda and Kenya.

Ixodes thomasae new species

(Figures 73-79)

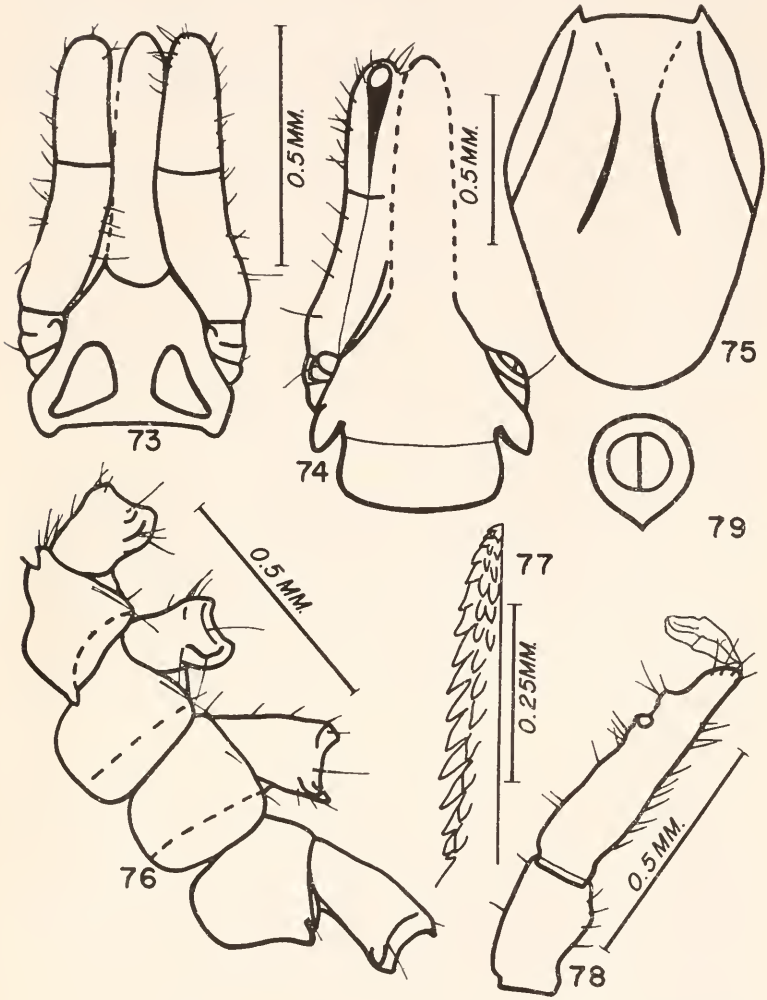
Holotype. Female, Host: HH 4093, *Arvicanthis abyssinicus nubilans,* Njoro, Rift Valley Province, Kenya, 7500 ft., 14 June, 1948, H. Hoogstraal *leg.* Deposited in Rocky Mountain Laboratory, Hamilton, Montana.

Paratype. One female, Host: HH 4106, *Otomys tropicalis elgonis,* Njoro, Rift Valley Province, Kenya, 7500 ft., 15 June, 1948, H. Hoogstraal *leg.* Deposited in British Museum (Natural History).

Description. FEMALE. *Body shape* of unfed female elongate oval, narrowing anteriorly, broadly rounded posteriorly, greatest width just behind the spiracle; Colour, sclerotized parts dark brown, alloscutum reddish brown in alcohol preserved specimens, well covered with white adpressed hairs of moderate length: Anal aperture far back. Scutum extends well beyond half opisthosomatic length.

Capitulum. Overall length from cornua to palpal tips 0.85 mm., breadth across dorsal ridge, 0.38 mm., dorsal ridge straight between cornua, latter small, broad-based with blunt apices, lateral margins slightly convex, divergent almost to level of palpal insertion, which is the widest point (Figure 73); surface reticulately patterned depressed around and in front of the porose areas, inter-porose area and surface adjacent to the dorsal ridge elevated, strong ventral curvature near antero-lateral borders. *Porose areas* subtriangular, slightly depressed, inter-porose interval less than the maximum breadth. *Palpi* long, about five times as long as the greatest width; lateral profile distinctly concave, with mesial convexity more or less parallel to it, apex rounded; length of article 2, 0.39 mm., article 3, 0.26 mm.; article 1 with small dorsally-directed flange-like spur arising adjacent to lateral margin of basis capituli: latter nearly one and a half times as broad as long. Ventrally (Figure 74) *basis capituli* more heavily pigmented than dorsally, reddish-brown pigmentation peripherally, surface reticulately patterned, flat, except behind the auriculae and the antero-lateral margins which curve away dorsally; posterior border broadly curved, postero-lateral edges sharply rounded, lateral margins gently and slightly constricted; greatest breadth (0.45 mm.) across auriculae, latter

well developed, tapering horn-like spurs which are flattened on their ventral surfaces, horizontal and directed postero-laterally;



Figs. 73-79. *Ixodes thomasae*, female; 73. Capitulum, dorsal; 74. Capitulum, ventral; 75. Scutum; 76. Coxae and trochanters I-IV; 77. Hypostome; 78. Tarsus and metatarsus I. 79. Anal groove.

pair of hairs posterior and lateral to hypostomal base; palpal article I with saddle-shaped spur from which a long white hair projects postero-laterally, mesial surface of article 2 flat, that of 3 slightly concave. *Hypostome* (Figure 77) long (0.57 mm.), narrow, tapering to a pointed apex, outer file of denticles larger than those nearer the mid-line and arranged from base to apex as 1 row of 1/1 files, 7 rows of 2/2 files, 6 rows of 3/3 files, surmounted by a small corona.

Scutum. Colour, brown; large, rhomboidal, longer than broad (1.32 mm. x 0.88 mm.) with greatest breadth in front of mid-length; antero-lateral margins faintly undulate and convergent to scapulae, postero-lateral margins straight, converging to posterior convexity. *Lateral carinae* distinct, broadening postero-laterally and reaching the margins just behind greatest width, lateral field beyond carinae sloping strongly. *Cervical grooves* weak anteriorly but on diverging become deeper and wider depressions about mid-length, do not extend to the periphery. *Punctations* medium size, moderate depth and uniformly distributed. Glabrous in holotype.

Legs. Small to moderate syncoxae on *coxae* I-III (Figure 76), short conical internal spur on coxa I, large external spur on coxa IV, all coxae trenchant; few hairs of varying sizes on all coxae. *Trochanters* I-III bear well developed broad rounded saliences, that on IV reduced to a smaller spur. *Tarsi* long, tapering with a distinct hump beyond Haller's organ (Figure 78).

Spiracular plate. Oval, with long axis transverse to corresponding axis of body, macula antero-ventral, dimensions 0.26 x 0.22 mm.

Anal groove. Circular and drawn out to a small point posteriorly, closed (Figure 79).

Genital orifice. Between coxae IV, genital apron large, oval, unilobed.

This species is named for Miss Dilys G. Thomas of the Administrative Staff of King's College, London, who has exhibited the greatest patience as well as a high degree of efficiency in dealing with our continual typing requirements on acarological matters.

Related species. See the key on page 535 and the information on page 531.

Hosts. Arvicanthis abyssinicus nubilans, Otomys tropicalis elgonis.

Remarks. Known only from Kenya.

Key to the known species of African Ticks allied to IXODES RASUS *Neumann by virtue of their possession of a closed anal groove.*

(Characters mentioned are sufficient to serve as a diagnosis of new species described herein.)

Females

1. Auriculae as sharp retrograde spurs ..... *Ixodes rasus*
   Auriculae otherwise 2
2. Coxa I lacking internal spurs 3
   Coxa I with internal spur 4
3. Cornua about as long as basal breadth, auriculae straight edged, directed postero-ventrally, coxa IV with slight external spur ..... *I.muniensis*
   Cornua shorter than basal breadth, auriculae lobed, directed laterally, coxae IV without external spur ..... *I.pseudorasus*
4. Auriculae lobed as in *pseudorasus*..... Variant of *I.pseudorasus*
   Auriculae tapering nearly to a point, directed postero-laterally 5
5. Posterior margin of venter of basis capituli extended laterally, trochanter spurs long, pointed. Hypostomal dentition 3/3 files for nearly the whole length ..... *I.procaviae*
   Posterior margin of venter of basis capituli not extended laterally, trochanter spurs as broad rounded saliences. Hypostomal dentition 3/3 for distal third ..... *I.thomasae*

Males

(The males of *I.muniensis* and *I.thomasae* are not known.)

1. Coxae II with short internal spur mesial and forward of the postero-internal position, basis capituli relatively narrow ..... *I.procaviae*
   Coxa II lacking such spurs, basis capituli broad 2
2. Syncoxal areas on coxae II and III extensive, scutum with steadily convex margins, projections on transverse ridge not well developed .... *I.pseudorasus*
   Syncoxal areas on coxae II and III not extensive, scutum with rectilinear margins, projections on transverse ridge well developed and large .... *I.rasus*

SUMMARY

1. The male and female of *Ixodes rasus* of Neumann (1899) are redescribed and the systematic status of the female of the species bearing this name, as described by Nuttall *et al* (1911), is critically reviewed. After examination of a large number of ticks we have arrived at the conclusion that the female of *rasus*, as described by Nuttall *et al* should be assigned specific rank as *pseudorasus*. No such great variation, as suggested by them, occurs in the specimens we have studied.
2. The subspecific forms of *I.r.cumulatimpunctatus and I.r.eidmanni* of Schulze (1943) have not been observed, and we consider that in certain respects his subspecific characters are inadequate for diagnostic purposes.
3. The male of *pseudorasus* is described and a variant of the female of this form noted.
4. Three other new species having closed, circular, anal grooves are described. These are *I.muniensis* (female, nymph, larva), *I.procaviae* (female, male, nymph) and *I.thomasae* (female).
5. All species appear to have a wide range of potential hosts.

REFERENCES

Arthur, D. R.
1956. The morphology of the British Prostriata with particular reference to *Ixodes hexagonus* Leach, III. Parasitology, **46:** 261-307.

Bequaert, J.
1931. Synopsis des Tiques du Congo Belge. Rev. Zool. Bot. Afr., **20:** 209-251.

Hoogstraal, H.
1956. African Ixodoidea Vol. I. The ticks of the Sudan. Dept of the Navy. Bureau of Medicine and Surgery. Pp. 1-1101.

Neumann, G.
1899. Revision de la Famille des Ixodides. 3. Mém. Soc. Zool. France, **12:** 107-294.

Nuttall, G. H. F.
1911. On the adaptation of ticks to the habits of their hosts. Parasitology, **4:** 46-67.

NUTTALL, G. H. F.
1916. Notes on ticks, IV. Relating to the genus *Ixodes* and including a description of three new species and two new varieties. Parasitology, **8:** 294-337.

NUTTALL, G. H. F., C. WARBURTON, W. F. COOPER and L. E. ROBINSON
1911. The genus *Ixodes*. A monograph of the Ixodoidea, Pt. II. pp. xix + 105-348. Cambridge University Press.

SCHULZE, P.
1943. Ueber zwei bemerkenswerte afrikanische Schwesterarten von *Ixodes: I.rasus* Neum. und *vanidicus* n.sp. Zool. Anz., **142:** 121-141.

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